Vol 3 with plan of

Roman Bath at

Bath. fo 222

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# AN

# ESSAY

## ON

# WATERS.

## IN THREE PARTS.

TREATING,

I. Of SIMPLE WATERS.
II. Of COLD, MEDICATED WATERS.
III. Of NATURAL BATHS.

By C. LUCAS, M. D.

ΙΠΠΟΚΡΑΤ. Περὶ Ἀερων, Ὑδάτων, Τόπων.
Δεῖ δε καὶ τῶν ὑδάτων ἐνθυμέεσθαι τὰς δυνάμιας.

HIPPOCRAT. De Aere, Aquis et Locis. ANUT. FOESIO interprete.
Quinetiam, AQUARUM Facultates animo reputare oportet.

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TO

HIS ROYAL HIGHNESS

THE

# PRINCE.

WHILE the admiring multitude of the fair and great, preſs with eager deſire to attend upon YOUR ROYAL perſon; an humble ſtranger at Your court begs to approach, and preſent a public teſtimony of his affection and duty to the Heir Apparent of the thrones of theſe kingdoms; in dedicating to YOUR ROYAL HIGHNESS, the Firſt-fruits of his phyſical labors.

I am well aware, that this, at firſt ſight, to ſome may ſeem an odd ſort of preſent to a Prince; a phyſical or medicinal Eſſay, out of the way of, or perhaps beneath, his attention.

But, if YOUR ROYAL HIGHNESS be pleaſed to reflect, that the God-like Art of preſerving or reſtoring the health of man was originally

practiſed by Heroes, Philoſophers, and Kings; that, of old, no branch of this Art was deemed too mean to be exerciſed by Prieſts, Prophets, or Princes; and that, of later date, it has been found an object worthy of the care and ſanction of the wiſeſt of Legiſlators and Potentates; the ſubject matter of this little book, however meanly it may herein be handled, can not be judged below the regard of him, who is one day to hold the reins of theſe great governments, and to be the SUPREME GUARDIAN of the natural, as well as political health of the people.

In antient times, before the rules and records of the healing art were eſtabliſhed and reduced to the juſt order, in which they now ſtand; the grateful votaries of the GOD of HEALTH poſted up in his temple, the hiſtories of their diſeaſes, and the means, by which their cures were wrought; with the juſt intent, at once, to ſet forth their own gratitude to the preſiding divinity, to teach others how to recover loſſed health, in the like caſes, and to prize it properly, when reſtored.

Without political health, life, with full enjoyment of natural health, and even with the greateſt affluence of the goods of fortune, would be very far from deſireable, in mine eſtimation. The former, in juſt preference to the later, was certainly meaned by thoſe wiſe and worthy rulers,

ers, who eſtabliſhed, as the principal axiom of their polity, SALUS POPULI SUPREMA LEX ESTO.

Every ſenſible member of our community muſt ever keep theſe things in view. Muſt love his country better than himſelf, and look upon the reſtorers and preſervers of it's polity, as the GODS of the PUBLIC HEALTH.

If your ROYAL HIGHNESS will permit me but to point out theſe, the motives of my dedication will be ſeen, and ward off the deteſtable imputation of adulatory or ſervile views upon this occaſion.

Amidſt the numberleſs violent diſtempers, that have from time to time aſſailed the ſtate; amidſt the many dreadful ſhocks and ghaſtly wounds, given the Body Politic, by weak or wicked governors, flattering, perfidious miniſters, and corrupt counſilors, the onely enemies our happy realms can fear; none more iminently threatned a fatal diſſolution, than thoſe given by that perjured race of princes, that broke THEIR COMPACT with their ſubjects, ſoon after the ſolemn renewal of it, at their coronations; and thereby, abſolved the people from their allegiance, diſſolved the political conſtitution, and left the late REVOLUTION the ſole expedi-

ent for ſaving our religious and civil liberties from utter ſubverſion.

By this alone, the diſſolved civil conſtitution, that paragon of perfect polity, like the fabulous Arabian bird, from it's own aſhes, roſe more vigorous, more reſplendent from it's awful ruins. The government was, as it was at firſt conceived and inſtituted, revived and reeſtabliſhed, by matchleſs wiſdom and virtue; on which alone, it muſt at all times depend for ſupport. The head and each member of the government was reſpectively taught his particular duty, the functions of his ſphere, and the extent and limits of his power, privilege and authority.

And thus, we once more ſaw the REGAL OFFICE reinſtituted, by the POPULAR VOICE; again adorned with all the MAJESTY of the PEOPLE, untainted with deſtructive deſpoticiſm.

To counſil and aſſiſt this firſt, this great eſtate, ARISTOCRACY, without OLIGARCHY, was joined; and to balance the firſt and ſecond, DEMOCRACY, without ANARCHY, was reſtored.

Thus, the POLITICAL CONSTITUTION was renewed; having all the excellencies of the beſt forms of civil government, without any of their

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evils, united in the three eſtates of KING, LORDS, and COMMONS, that conſtitute our GLORIOUS COMMONWEALTH; and their reſpective powers and privileges aſcertained and blended, in ſuch equal, ſuch attemperating proportions, as ſtrengthens, balances and ſecures the whole, and leaves none of the conſtituent parts, not even the inferior limbs of our body politic, room to repine at his lot; ſince, the meaneſt is as free in his low, as the greateſt in his exalted, ſphere; and the laſt, as well as the firſt, gives his conſent, in his proper perſon, or by his repreſentative, to the ſyſtem of laws, by which he is at once governed and protected.

Who can reflect on this, and not exult at being born a BRITON?—Who can enjoy theſe matchleſs, theſe invaluable bleſſings, without remembering, with a thankful heart, the SOURCES, whence they were drawn? Who can be ſo ungrateful, ſo inſenſible, as to overlook or forget THOSE, by whom they are now maintained, and promiſed to be perpetuated?

I ſhould judge myſelf unworthy of theſe unparalleled benefits, could any means be able to efface the grateful ſenſe of them, imprinted on mine heart. The juſteſt of our politicians judge, that PROTECTION and ALLEGIANCE are obligations, mutual and reciprocal, between the Governor and Governed; and that, when the

one is withdrawn, the other ceaſes to be a debt.

Yet, pardon mine ambition, to let YOUR ROYAL HIGHNESS ſee my ſentiments of loyalty and gratitude upon this occaſion; though I am, I hope, the Onely living ſubject, that can of a truth complain of having been denied the potection, that even criminals enjoy from our laws; having notoriouſly ſuffered the Oppreſſor's Wrongs, the Laws Delay, and the Inſolence of Office, to ſay no more; and that, without any taſte or proſpect of redreſs; Notwithſtanding, I can call upon my bittereſt enemies to atteſt, that it has not been in the power of perſecution and adverſity to pervert my ſenſes, ſo far as to make me impute the unauthoriſed outrages of Subſtitutes to the PRINCIPAL, or make me one moment diſregard or forget the DELIVERERS of my country, the RESTORERS and PRESERVERS of our moſt valuable, our POLITICAL HEALTH.

Whatever the flatterers of tyrants might have heretofore inſinuated, it is now confeſſed in truth, that all kings are of human appointment; and that whatever might have been the caſe among the antient Jews, no nation can now boaſt any other.

Yet, in a figurative ſenſe, they may well be deemed the ANOINTED of HEAVEN, who lay clame

clame to the ſacred titule, by proving themſelves moſt truly HEAVEN'S VICEGERENTS. The FOUNDERS firſt, and after theſe, the RESTORERS of our great National Conſtitution, deſerve our principal veneration; and next to theſe, we ſhould ſurely bear it's PRESERVERS in our hearts.

Our Deliverance then, ROYAL SIR, had poſſibly been but momentary, had not the wiſdom of our deliverers intailed the REGAL OFFICE upon a Family, long diſtinguiſhed by Heaven as it's Vicegerents, upon the continent, in the reſtoring and protecting the true religion, and good civil policy, where both had been long overturned by ſuperſtition and tyranny; and, had not that moſt ILLUSTRIOUS, that CHOSEN FAMILY, anſwered the CALLS of THIS PEOPLE, as the VOICE OF GOD, and acceded to the thrones of theſe Redeemed Realms.

The honeſt, the truly affectionate and loyal man can never flatter YOUR ROYAL HIGHNESS. It is a vice, that deforms human nature. It is a moſt ſubtil, ſure poiſon; whoſe influence is not often perceived, before it's deadly work is performed. Few, if any men, are proofs againſt it's bane; and unhappily, princes, being generally more early inured to it, are of all men the leſt aguard againſt, though of all others, the moſt expoſed to, it's dire effects.

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As beneath the dignity of a free-born, undesigning man, and injurious to YOUR ROYAL HIGHNESS, as well as inconsistent with the disinterested love and duty, I bear YOU; I shall avoid all handles to the imputation of this destructive vice, the common sauce to make unsavory dedications palatable.

YOUR ROYAL HIGHNESS will therefore give me leave to declare, that it is not from any hopes or fears, I feel; from any degree of that servile reverence, that slaves pay their sovereigns; from any propensity to repose implicit or boundless confidence in princes; from any tendency to passive obedience, and much less is it from any regard to the ridiculous absurdity of an Indefeasable Hereditary Right to Tyrannise; that I pay my devotion to the ROYAL FAMILY, that now does honor to the British throne, or thus address myself to the HOPEFUL HEIR APPARENT of the crowns of our kingdoms.

Could I be thus mean and servile, I should in no respect be qualified to address YOUR ROYAL HIGHNESS upon this, or indeed upon any other, occasion. But, my views are very different from such as these motives prompt: A religious reverence to the laws must ever make me ready to render unto CAESAR, the things that

that are CAESAR's. But, reaſon, clear conviction, and a ſenſe of gratitude muſt carry me further, and dictate more exalted ſentiments.

Thoſe make me look back, and trembling recollect the ruin, that threatned theſe kingdoms, during the laſt years of a late regne, in ſpight to all, that was provided for us, by the REVOLUTION and the ACT OF SUCCESSION.

Auſpicious Heaven ſaw our diſtreſſes and dangers; and bad YOUR GREAT GRANDFATHER diſpel our fears. He came. He filled the throne with dignity. He fulfilled his miſſion, He anſwered the expectations of his people. He reſtored Parlements to their priſtine weight and authority; and, as he ſquared all his political conduct by their counſil, Britain again was free.— If any diſorder aroſe in the Body Politic, while he preſided over it's health; the cauſe, upon juſt enquiry, will be found among the Members; by no means in the Head.

When it pleaſed the Ruler of Princes to tranſlate this Hero to a more exalted crown; His ſon, YOUR ROYAL GRANDFATHER, ſucceded to his virtues, with his temporal throne.

To avoid the moſt remote appearances of adulation, as well as repetitions of ſentiments, I have already, to my coſt, recorded of his

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MAJESTY[a], I ſhall ſay no more of him at preſent, than pray, that he may live long to ſhare in the health, natural, religious and political, in the general happineſs, which he ſecures to his faithful people! And ever be able, juſtly to diſtinguiſh his real, from his pretended, friends!

And, though the recital muſt renew YOUR ROYAL HIGHNESS's, with the public, grief; I muſt beg leave to mention YOUR ROYAL FATHER, who eminently poſſeſſed every ſocial, every princely virtue. His death muſt have proved cauſe of endleſs affliction to the free ſubjects of theſe realms; had not bountiful Heaven provided for our future happineſs, in giving him a numerous, moſt hopeful offspring, by a PRINCESS, formed to give luſtre to the higheſt rank in life. From ſuch ſtocks, what good fruits may we not expect?

Who can take this tranſient view of the ſtate of our POLITICAL HEALTH, and not with unſpeakable gratitude and admiration obſerve, the cauſes of preſent exultation, and of future hope? Who can be at a loſs to judge, when,

[a] In the DEDICATION of my Tranſcript and Tranſlation of the Great Charter of Dublin to the King; In the COMPLAINTS of Dublin, addreſſed and preſented to the Lord Harrington, then his Lieutenant, in Ireland; In the POLITICAL CONSTITUTIONS of Great Britain and Ireland, and other loyal tracts; for which, by the matchleſs conduct of that extraordinary adminiſtration, mine election into parlement, for the Metropolis, was violently prevented, and I was, by lawleſs outrage, forced into exile.

and

and by whom, the golden axiom, before recited, SALUS POPULI SUPREMA LEX, was, is, and hereafter is likely to be, the fartheſt extended, and the moſt fully obſerved?

When then, it is conſidered, what an impreſſion this GOD-LIKE CONDUCT of governors muſt make upon ſenſible and grateful minds; upon allowing me the ſmalleſt ſhare of theſe endowments, from this curſory application, MY PRINCE will obſerve, and graciouſly indulge, the motive of this dedication; eſpecially, as YOUR ROYAL HIGHNESS may ſee, that I am not onely grateful for paſſed and preſent public, abſtracted from all views to private, benefits; but, that I go ſtill further, and comfort my country and my ſelf with the pleaſing aſſurance, that, when it ſhall ſeem good to the ſupreme Ruler of Kings to reward the care and labors of the preſent GREAT PHYSICIAN of OUR STATE, with a far nobler diadem, than that, which at preſent gives and receives a luſtre from his brow; if then, any ſhould remane ſo ſtubborn, ſo froward, or ſo ungrateful, as not to take the Remedy properly, or to acknowledge it's full benign effects; their cure and conviction muſt one day be wrought by YOUR ROYAL HIGHNESS; who ſeem to be born to diſarm and diſſolve contending factions, to recover the loſſed ſheep of our fold, to call the prodigal children home, and to unite them in ONE FAMILY,

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infolded within the arms of a tender and indulgent Parent, whom diſtant ages ſhall hail, FATHER OF HIS COUNTRY.—Theſe wiſhes, the love of my country prompts.— Theſe hopes, YOUR ROYAL HIGHNESS has raiſed.

Vouchſafe then, MOST GRACIOUS PRINCE! to permit me thus to record my grateful ſentiments in the temple of the GODS of OUR POLITICAL HEALTH; while I take the liberty of preſenting You with this ſmall tract, calculated for the ends of mine humble ſphere, to miniſter to the natural health of the ſubjects; And deign to accept of it, as a Free-will offering, and to conſider this addreſs as part of the overflowings of an heart, zealous to promote the public good, and ambitious to prove, what he has the honor of declaring, himſelf,

YOUR ROYAL HIGHNESS's

Moſt dutiful,

Moſt faithful,

And

Moſt devoted,

Humble Servant,

C. LUCAS.

# THE PREFACE.

IF any body remanes ignorant of the greatneſs and importance of the ſubject of the following ſheets; however meanly the matter may be handled, a ſlight peruſal of them can hardly fail of clearing his conceptions, in this inſtance.

It will appear ſtrange to every attentive reader, that the moſt uſeful and neceſſary part of the creation, whether oeconomically, phyſically, or medicinally conſidered, has been ſo far, and ſo long neglected, as to make it, at this day, neceſſary to compile ſo large a volume as this, to rectify men's notions in ſo intereſting a point!

This will aſſuredly appear no ſmall reproach to our profeſſion; when it is found, that however ſome of greater eminence might, in this, among other inſtances, have labored for the information of their own private judgements; yet, none of them have thought fit to impart any ſhare of their knowledge, in this particular, to the public.

It were happy for the public in general, as well as for the author of the following tracts, that ſome of the firſt claſs among us, had ſet their hands to this weighty undertaking, and reſcued the ſubject from the pens of ſuch as muſt be found leſs qualified.

But, ſince none of theſe ſeems to judge it fit to imbarque in ſuch a work; it will not, I hope, be deemed arrogant in me to offer the public ſome informations in this matter, which the ſilence of the better qualified, and the impertinent intruſions of the diſqualified, have alike rendered evidently neceſſary; eſpecially, in

this country, where waters make not onely a conſiderable part of the Materia medica; but where the generality are ſo apt to run in crowds to, and drink exceſſively of, all the medicated waters of theſe kingdoms, and even of the continent.

To ſuch, an humble attempt to reſcue this intereſting ſubject out of the hands of the ignorant, the deſigning, and the deceitful; and few others have with us taken much pains in this way; can hardly be unacceptable. For theſe, I wrote it. To theſe, I now offer it; with the pure intention of diſcharging the duty of my ſphere in life; miniſtering, in the moſt extenſive manner in my power, to the health of the community.

Nothing, but a thorough perſuaſion of the extreme neceſſity, as well as utility of ſuch an undertaking, could prompt me to engage in it; at leſt, to publiſh it, as prematurely as this, I fear, will appear. But, my fate, if I may uſe the phraſe, reduced me to this alternative; either to write and publiſh quickly, or run the riſk of letting the public longer, or perhaps for ever, want the little informations, I conceived, I might give them: My time and circumſtances will not permit me to write and collate carefully and deliberately: Since tyranny baniſhed me my native country, and corruption left me no means of a reſtoration; I layed my ſelf out for completing the ſtudy of phyſic; for which, in a miniſterial branch, I had before layed ſome foundation. It is eaſier to conceive, than deſcribe, the uninterrupted ſeries of affliction, anxiety, care, and perplexity, that has ever ſince attended me.

Theſe conſidered, it can hardly be expected, that this tract ſhould appear completely, or perhaps decently, equipped for a public appearance, before ſevere judges. But, ſuch as it is, it muſt have been given, or not all. I hope the readers, if ſuch there be, will think, that, in this premature publication, of two evils, I have choſen the leſt.

Let

Let not the miſerable word-catcher, who lives on ſyllables; or the griping critic, who wades through maſſive volumes in ſearch of faults, regardleſs of beauties, and feeds on human errors, as ſome baſe animals, on the excrements of others; let not the vindictive multitude of wretched writers, who are impatient to make ſome repriſals for expoſing their quack-bill diſſertations upon their favorite all-healing waters; let none of theſe imagine, I mean to court their indulgence, or their favor: No; I invite them, or if they chooſe the term, I challenge them, to examine it with all the rigor, that rage can prompt; with all the juſtice, they can bring on their ſide; and in whatſoever light ſhall beſt ſuit their tempers and their intentions, point out every error, I have committed, or the preſs for me, and ſeverely ſcan every fault of mine or the printer, though naturally overlooked by the author. When they have done their worſt, if they are able to bring truths to light, they muſt coincide with mine intentions; who, however miſtaken I may be found, have nothing more in view.

It is to be hoped, this declaration will ſatisfy the multitude, that have greatly affected to depretiate mine undertaking, by threatening, if ever I publiſhed any thing, to anſwer it. Some of theſe, I am told, have long ſince got their criticiſms ready for the preſs, upon a work, of which they never ſaw a line, except ſince it was printed, and that by ſtealth. And one of theſe, a gentleman of no ſmall weight, as I am told, in point of perſon; but, with whom I never had the honor of exchanging a monoſyllable; ſome months before this publication, promiſed, or rather threatened, in the hearing of a friend of mine, "that the anſwer to my book, ſhould appear as ſoon as the book itſelf." I hope, this Critic will be as good as his word; and ſerve, if not oblige, the public, in expoſing either himſelf, or me, or both, in a true light; for, knaves and fools ſhould by all means be excluded, or cut off from, the profeſſion of phyſic.

But, this is nothing to the magazine of thunder-bolts, that are ſtored up for me at Bath: There, a ſet of learned gentlemen, for none other crime, than that of differing from them in opinion; a privilege, become proverbial in the profeſſion; have not contented themſelves with the moſt inhoſpitable ſlights of a ſtranger, in their city; but have chafed their righteous ſpirits, to a moſt tremendous, I dare not ſay unbecoming, pitch of wrath and indignation againſt me; and now, heſitate at no reproachful expreſſions of malevolence and calumny. Of all the various ill-natured means of detraction, that have yet been deviſed by theſe angry ſages, the moſt remarkable, are the calling my moral and political character, and even mine underſtanding, in queſtion, and attempting to caſt reflections from my late profeſſion.—"Who is this," ſays one, "that is come to decry our waters?"—"A fellow," anſwers another, "that was forced to fly his own country, and will never be quiet, till he is forced to fly this."—To this, I ſhall make no reply. I have been forced to fly my wretched country. But, let the tyrant ſlaves that baniſhed me, tell why; and then, the judicious and diſpaſſionate may diſcern who, by my exile, ſtands moſt diſgraced.—"Ay," ſays a third, "I have heared of him; no body will mind him; a mere mad man!"—How true this charge may be, I ſhall not diſpute: In ſuch an accuſation, my pleading and mine evidence, in behalf of myſelf, muſt weigh equally light. Let then the world at large judge of me; while at Bath, I onely plead, Coram non judice; and, at the ſame time, offer the patients of theſe prejudging ſages, the comfortable aſſurance, that theſe their good doctors are hardly in any danger of ever being mad: For, this extreme, the phlegmatic and the fool alike eſcapes.—However ſome of the Bath doctors may be divided in their judgement upon me, in the laſt inſtance; in another point, which is looked upon as a ſevere reflection, they are pretty unanimous; that is, in pronouncing my name with a, "The Apothecary."—A terrible ſtigma!—I proudly own the charge; I was,

I hope,

I hope, I ſtill am, an Apothecary. It had been happy for the public, that they, who caſt this, as a term of reproach, could ſay as much for themſelves: Since it is moſt plane, that he, who is not an Apothecary, and a Chirurgeon, can not deſerve the name of Phyſician. —A child, being aſked, who ſeveral perſons in a room were, pitching upon one in a clergyman's habit, ſayed, "You are a ſcholar;" and upon another in an officer's dreſs, "You are a ſoldier." Upon being reprehehended for impoliteneſs, and inſtructed in their reſpective ranks, he amended his ſpeech, ſaying to one, "O! Sir, I miſtook; you are a biſhop, not a ſcholar; and you are a general, not a ſoldier."— The reader may avoid the application, if he can. And theſe good phyſicians, who probably diſdain to be apothecaries, may let their paſſion gradually ſubſide; when I thus fairly advertiſe them, that their thunder will vaniſh without noiſe, flame, or ſmoak; that their whole train of artillery is uſeleſs; that their maſked batteries muſt be ſilent; when they examine their magazines more accurately, and find that they have nothing combuſtible in all their vaunted ſtores. Their lightening and thunder then, will be found merely theatrical; at moſt, a flaſh of ſmoaky reſin, and the rumbling of a leaden bullet in an empty trunk: Unleſs they have diſcovered the method of making gunpowder without brimſtone.— But come; the anger with the fears of theſe fretted philoſophers will by and by ſubſide; when they muſt ſee, if not wilfully blind, that I went to Bath in queſt of phyſical truths, not private gain; that in pure regard to the public, and for the general honor of the profeſſion, I did, and now thus endeavor to promulge theſe intereſting truths; and eſpecially, when they find, that I do not in fact, decry Bath waters; but ſhew their powers in a different and more juſt light; and if men will then worſhip images, what matters it of what materials the idols are made? Lot's wife is ſurely as good a divinity, as any that can be taken out of the ruins of Sodom or Gomorrha.

morrah. If they muſt have a Pagod, let it be a real, not an ideal one; the ſalt, earth, and metal in the water may ſurely be moulded into a more ſubſtantial, ſolid god, than imaginary, or even real, brimſtone.

But, that the impartial may be able to judge of my blameleſs conduct towards the frighted faculty at Bath, let it be remembered, that mine enquiries concerning their famed waters, were not made in a corner; nor any material experiment or diſcovery I made, kept a ſecret. Let it be noted, that I conceled nothing from any body, that aſked for ſuch information, as I could give in theſe matters; that I never declined making a ſeries of teadious and laborious experiments and demonſtrations, for any that aſked me, and that I publicly, repetedly, deſired a conference with the gentlemen of the profeſſion of phyſic, in hopes of convincing them of their errors, or receiving from them, conviction of mine own: And, that mine offers were not onely rejected, but that I was induſtriouſly avoided, by the generality of thoſe truſty miniſters of the favorite baths of Apollo; while I was in groſs terms, in mine abſence, abuſed by a certain anonymous, anomolous wight, who attempts by force to intrude into the number!

Some may conſtrue this a kind of pride, or ſome contempt of a late Apothecary. But, this muſt appear but an unjuſt conſtruction; if there was no reaſon to apprehend, that that Apothecary crept by illicit ſteps, from the miniſterial branch, to the head of the profeſſion. Beſides, it muſt appear quite groundleſs, when it is conſidered, that the ſacred oeconomy of the healing art is ſo far perverted, at Bath, as well as elſe where, that theſe, once, miniſters of the faculty are treated by the generality of thoſe, that ſhould be their ſuperiors, with ſome degree of ſervile complacency. Of this, I dare ſay, I might have had a neighbour's ſhare, had I followed the profeſſion of pharmacy at Bath. But, theſe ſovereign Rulers of phyſic, theſe Prieſts of the myſteries, and Keepers of the Baths of the Sun, could not bear, I ſhould now be conſidered, either as a phyſician,

ſician, or even as an apothecary among them!— Let the Juſt judge the cauſe, and condemn, if they find, any part of my conduct, towards theſe iraſcible, jealous gentlemen, culpable!

The ſacred regard and deference, ever due to the judgement of ſociety, induces me to think it incumbent upon every man to explane to the world, or aſſign a cauſe for, every part of his public conduct.—The method, I endeavor to obſerve, in this work, as well as time and circumſtances would admit, will, I hope, appear unexceptionable; though I may not always have been found able to purſue it with deſireable ſtrictneſs, accuracy, and conciſeneſs. My firſt care was to obtain and give the reader the beſt idea, I was able to collect and convey, of thoſe bodies, by whoſe means, waters are capable of being compounded. This is done in the IDEA of SALTS.

After this, I endeavor to give the cleareſt idea of water, by explaning the nature and properties of SIMPLE WATER. In which, I do not pretend to be an original; but, gratefully acknowledge, in this, as well as numberleſs other inſtances, having received many and great helps from HOFFMAN, BOERHAAVE, MUSHENBROECK, and others; which I have endeavored to arrange in the fulleſt force, in which I was able to place them, to illuſtrate the ſubject.

This done, I next procede to explane the moſt familiar and rational method of EXAMINING and CHOOSING SIMPLE WATERS in general; in which, I have rather inclined to prolixity, perhaps fallen into repetitions, rather than by a too great attention to conciſeneſs, or a too rigid adherence to formal rules, omit giving the fulleſt information in my power.

This part, if not ſome others, from the ſame cauſe, may probably prove teadious and heavy to the learned in our way, if ever it may hope to fall into ſuch hands. The ſcope was large. The field uncultivated. I ſpared no pains upon it. And, I hope, it will be found to contain, though perhaps in much rude diſorder, a kind of HYDROLOGIA PHYSICO-CHEMICA, if not the whole

art of chemically proving waters, in general, whether ſimple or medicated.

After examining the ſimple waters of the city of London, upon the plan layed down; I thought it juſt to explane the MEDICINAL QUALITIES and USES of SIMPLE WATERS, and the various methods, antient and modern, of adminiſtring or applying them, whether internally or externally. In all this, I ſhall be found indebted to many of the beſt writers, that have gone before me; eſpecially, where I am forced to offer ſome ſketches of phyſiology as well as pathology.

The ſimple, as the baſis of all compound, waters, being thus fully explaned; the nature of the medicated waters becomes more comprehenſible. The tranſition from thoſe to theſe appears eaſy and natural. I begin then, with the moſt common and ſimple impregnations, and purſue the enquiry, a Notis ad Ignota, to the moſt complicated and ſeeming inexplicable compoſitions of mineral waters, that came in my way. Surely, the attempt, if not the performance, may hope for ſome degree of the approbation of the judicious! And none other can be acceptable.

In all this, I have labored to be explicit: Which led me unawares, if not neceſſarily, into repetitions and prolixity. They that will not accept of SWIFT's apology for writing a long letter, may lay aſide the teadious book, which I had not time to ſhorten.

I well foreſee an attempt to write intelligibly to the vulgar in their own tongue, will be condemned by the generality of thoſe, who chooſe to write in the dead languages, and dread nothing more than their works being made to ſpeak Engliſh. The chief cauſe, that ſuch affect to aſſign for this, is the fear of multiplying the ſhameful number of deſtructive quacks, that diſgraces, and tends to depopulate the ſtate; while, with the unthinking, it glances ſome obloquy upon the healing art.

I can not, in all this, agree with theſe learned gentlemen. It is certain, that to thoſe, who are maſters of the Greek and Latin, it is much more eaſy to treat a phyſical

phyſical ſubject, in either of theſe languages, in which moſt of our original writings are found, than in any of the modern tongues; ours, confeſſedly the moſt copious of all others, not excepted. And, whoever is moſt perfect in our tongue, muſt find it moſt difficult, if not impoſſible, to explane all phyſical ſubjects clearly in a language, which muſt be forced to borrow terms from the original ſources, whence the ſcience ſprang.

But, ſince we have framed or adopted terms, that are become ſufficiently intelligible, why ſhould we heſitate at propagating the knowledge of any, eſpecially of this moſt uſeful of all arts?— Why ſhould we not endeavor to make all ſpeak Engliſh? And if we can not bring ſciences and arts down to our language; what hinders our raiſing our language up to them?

It is feared, by ſuch gentlemen, that it may multiply quacks.— I think otherwiſe. I am not ignorant of the ſufferings of the duped populace in this inſtance. No man can be more ſenſible of the evil, no man more laments the degeneracy, the univerſal depravity, the total perverſion of all order in the oeconomy of phyſic, in theſe kingdoms. It was this firſt moved me to draw my feeble, juvenile pen to ſhew the neceſſity of a reformation[a]. In vane, did our wiſe forefathers divide the practice of phyſic into three parts, giving up to their ſervants the mechanical or miniſterial branches, that the maſters may have more leiſure to attend to the more material, the judicial parts, and to the culture, direction and ſuperintendence of the whole. We have lived to ſee all this reverſed. And all run into confuſion, worſe than primitive! We ſee the ſhops of apothecaries in particular, and their whole province, ſo entirely neglected, that the generality are as ignorant of the real buſineſs of the apothecary, as any of the worſt bred phyſicians can be ſuppoſed; ſo that the beſt preſcriber can hardly

[a] In a pamphlet, intituled PHARMACOMASTIX; or, the Office, Uſe and Abuſe of Apothecaries explaned, &c. Dublin, 1741.

confide in his own preſcriptions; when their effects vary, according to the character of the ſhop, in which they happen to be diſpenſed; whileſt the owner, perhaps without any one of the requiſite qualifications, for any one branch, takes upon him the whole! What ſenſible man does not feel the dire effects of this confuſion?— Who does not wiſh to remedy the preſent, and to prevent the growth of this ſpreading, evil?— I do. And if reaſon and the authority of the legiſlature do not ſoon put a ſtop to this inverted practice; if the apothecaries are encouraged to quit their proper ſtations, by being thought fit, and preſuming to perform the functions of the phyſician, as well as of the chirurgeon; I think it will be incumbent on the phyſicians to moderate their own fees, which may be done, at the ſame time abridging the quantity of medicines, and the expence to the patients; by reſuming the branches, given into unworthy hands, and furniſhing their patients with ſufficient and adequate remedies, prepared under the preſcriber's eye, without any additional charge to the ſick.

This, I propoſe, as one, though the ſevereſt and laſt, remedy. One, by which apothecaries muſt be reduced to their primitive ſtations, and the public muſt be better ſerved; though at the expence of the phyſicians, and to the prejudice of the public in the end: This muſt effectually put a ſtop to one branch of quackery, and prevent the growth of others. But, as it muſt embarraſs both the ſtudy and practice of phyſic, already, in ſpight to the ſtricteſt regularity, too extenſive for the ſhort life of man; I propoſe the trying, as another, and a milder expedient, the writing upon all phyſical matters in as plane Engliſh, as poſſible; as the ſureſt means of expoſing quacks, and raiſing the duly qualified, the real phyſicians, to the higheſt, the deſerved eſtimation. For this, we have the example of our predeceſſors: What Roman phyſician was ever known to write in Greek?—What Greek, in Arabic?—What Arab, in Chaldaic or Hebrew?— None, that we know of:

of: Each wrote in his native tongue. Each was revered in his native country. Thus AVICEN, MESUE, HIPPOCRATES, GALEN, CELSUS, &c. were admired by the then preſent, as well as bleſſed by all ſucceding generations, for the ſervices done their reſpective countries, and mankind in general, in their works.

Let Britons go and do likewiſe.— Let us cultivate our own excellent language, and publiſh whatever we have to offer the public, in the vulgar tongue. This will make it the intereſt of foregners to ſtudy our language; which may thus in time become as univerſal, as our extended dominion on the main.

This can never be thought to ſerve the intereſt of a degenerate race of quacks. On the contrary, it will enable the public to detect their inſufficiencies, as well as their fallacies. Beſides, it is a ſuperficial knowledge in phyſic, that makes men turn quacks, with the ſcanty furniture of a parcel of recipes, or truſt to thoſe, that are not better ſtocked. Enlighten then, their underſtandings further, remove the vane notions of myſteries, in phyſic; ſhew the dignity, the weight, the difficulty of the taſk of preſerving or reſtoring the health of man; and who then, will venture to quack or be quacked?

Theſe, with other reaſons, induce me to offer this eſſay to the public, in my native tongue. And, I hope, mine intentions will make it acceptable to the judicious and public-ſpirited.—— Let the galled jades wince!

As I wiſh to ſee our language further improved than it is, I have taken ſome liberties with the orthography, in which, I am hardly authoriſed by any authentic precedent. For theſe, ſeeming innovations, the public will accept mine apology.

The modern Engliſh is probably leſs of an original, than any living language in Europe: We have borrowed from all the living and the dead. And it muſt ever be much to our honor, and keep us clear of the imputation of plagiariſm, to continue the words, we in-

introduce from foregne tongues, as near the originals, as the too indeterminate idiom of ours will admit.

This will make our language more eaſily acquired by ſtrangers, as it muſt become more intelligible to the learned of all nations. And this will keep us clear of deſpicable Galliciſms, in avoiding the vices of that tongue and people; who, like us, have been forced to inlarge their language, at the expence of others; but have not kept near the original, in ſpelling or pronunciation. Shall we borrow and retain the faults, the corruptions of the French? God forbid!— For my part, I ſhall oppoſe and reject them, wherever I meet them. And in this inſtance, inſtead of taking from them, the words, that they firſt ſtole from other tongues, and mangled without rule or ſenſible deſign; though all our greateſt writers have adopted them, I chooſe to depend upon the original, rather than implicitly receive the corruptions and inelegancies of any new or borrowed tongue, however I find it in faſhion.

But, Galliciſms are not the onely corruptions, crept into our language. Our own poets have taken moſt unpardonable liberties, in miſpelling and otherwiſe lopping, and cropping of words, to adapt them to their rhymes or numbers, or to make them run the ſmoother in their jingling lines; in which the lower claſs eſpecially, have generally been more mindful of ſound than ſenſe. This may be eaſily conceived by reviewing the unnatural participles commonly formed of the verbs, to fix, to mix, to loſe, to toſs, to lop, to crop, and numberleſs others. I ſubmit it to the judicious, whether it be more juſt and eligible to follow blind cuſtom, or to aim at ſome deſign and rule, in theſe matters.

I know, the novelty, the ſeeming innovation, will meet it's objections. And it will to ſome appear moſt daring and preſumptuous, if not impudent, to attempt to ſwerve from the ſpelling, received and eſtabliſhed by the many great authors, which this and the preceding century have produced.

Let

Let it be remembered, that our language, by none other authority, than that of thoſe, who thought fit to write in it, has gradually changed from the days of Chaucer, to the laſt century, perhaps to this. This, upon the whole, has not been condemned: Our tongue is confeſſedly improved. But, no man will ſay it is yet perfect. Let then every writer propoſe his corrections and amendments of our ſtile and diction, to the public; without that religious, or rather blind, attachement to the authority of predeceſſors, with which ſome ſenſible men ſeem pinioned; till the legiſlature ſhall think fit to eſtabliſh a general ſtandard.

In matters of any weight, precedents, which have not their foundations in truth and reaſon, ſhould be of none authority, with men of ſenſe. Otherwiſe, there can be no chance for a reformation in any matter, that has the grave ſanction of time and cuſtom. I hold myſelf no further bound to write as my predeceſſors did, without the concurrence of my little ſhare of judgement, than our poets thought themſelves obliged to follow one another, in theſe inſtances. He, that anſwers himſelf this queſtion; why did not Spencer follow Chaucer; Milton or Cowley, Spencer; or Dryden, Pope or Swift, literally follow the ſteps of theſe? will find mine anſwer for ſwerving a little from the modes, which the authority of ſuch had eſtabliſhed for ſpelling.

Moreover, let it be conſidered, that in moſt of the ſubject matter of the following work, I have the authority of the dead and living writers, almoſt to unanimity againſt me. Shall their authority and the influence of cuſtom ſo far circumſcribe me, that I ſhall not examine this matter, but be obliged to ſubſcribe to all the errors of grey bearded predeceſſors, contenting my ſelf with a Sic voluere patres?— I believe this will hardly be inſiſted on, in the one inſtance, more than in the other.— Except at Bath; where it ſeems, it would be moſt pleaſing to the city, as well as to the guardians of her health, to let their waters be ſuppoſed, as aſ-

ſerted

ſerted to be, impregnated with ſulphur.— Is it not to be deemed moſt audacious to oppoſe the weighty authority of all the learned and great writers on this important ſubject?— Is it not rather brave, juſt and neceſſary to oppoſe the tyrant cuſtom, whereſoever he is found to rear his obſtinate, hoary head, in defence of error or ignorance? This have I done: No more.

It will probably give the ſenſible and humane reader ſome diſguſt, as well as pain, to ſee the long catalogue of errata, that disfigures this work. I wiſh ſuch may not be offended, by finding many more, which the author, for want of time and leiſure, or from a natural partiality and blindneſs to his own faults, muſt have overlooked.

As a farther apology for theſe, I muſt requeſt, it ſhould be conſidered, that this work, though partly begun upon the continent, was undertaken, long ſince my return from my ſtudies abroad; which is now about three years: Since which time, I have given two long, laborious courſes of chemiſtry, and am now engaged in a third. It is eaſy to conceive from theſe, and the ſhare of practice, with which the indulgence of the public has ſince intruſted me; what a variety of avocations from this work, muſt have always attended me. Such errors as might thus be occaſioned, by the printer, by the author, or by both, demand ſome lenity in the correction. But, this is ſubmitted to the judgement of the reader; for whoſe information, I determined to expoſe ſuch errors and omiſſions as occurred to me, as near as might be to the front of the work; where he may read grief with conviction in the author's face.

If any are humane and public ſpirited enough to wiſh this work correct and complete; their corrections and amendments ſhall be moſt gratefully received, and publicly acknowledged, if the book lives to undergo another edition.

THE

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Their fit temperature, § 583.
Two other kinds of warm baths, § 584.

The

# These, among other necessary CORRECTIONS, to be made in the reading, as follow.

## PART I.

### IDEA *of* SALTS.

PAGE 2. line 8. and every where else, for its, read it's.
§ 5. l. 3. for floating, r. floting.
§ 6. l. 5. for exceeding, r. exceding.
§ 12. l. 9. for doe, r. do.
§ 13. l. 5. for remaining, r. remaning.
22. l. 4. and every where else, for distillation, r. destillation.
§ 30. l. 1. for only read onely.
§ 40. l. 1. and every where else, for arteficial, r. artificial.
§ 43. l. 14. for Æthiops, r. Aethiops.
§ 45. l. 11. after with, add, some.
§ 47. l. 12. and every where else, for grains, r, granes.
§ 54. l. 9. for in this acid, r. therein.
§ 55. l. 30. for colour, r. color. and every where else, in this and similar words, strike the u, out of the last syllable.
§ 65. l. 7. and every where else, for crystaline, r. crystalline.
§ 66. l. 12. for reabsorbs, r. resorbs.
§ 67. l. 1. 2. for abbent, r. absorbent.
§ 77. l. 10. for larger, r. layer.
l. 11. for pellicle, r. pellicule.
§ 87. l. 4. for succeed, r. succede.
§ 230. l. 12. afer, if, add, into.
l. 13. after dropped, d. into.

### *Of* WATER *in general.*

§ 10. l. 3. for particles, here and else where, r, particules.
l. 5. for float, in general, r. flote.
§ 20. l. 2. for freeze, r. freese.
§ 22. l. 12. for heighth, r. highth,
§ 24. l. 7. and elsewhere, for mountains, r. mountanes.
§ 27. l. 5. for lie, r. lye.
l. 8. for consideration, r. considerations.
l. 18. after are, add, often.
§ 30. l. 4. for least, r. lest.
l. 10. after and, add, thence.
§ 32. l. 14. for latter, r. later.
§ 45. l. 9. for whilst, r. whilest.
§ 49. l. 7. for bodies, r. subjects.
§ 68. l. 3. after oils, add, and acids.
l. 25. for liquidity, r. fluidity.
§ 77. l. 1. after two, add, half ounce.
§ 80. l. 24. after heat, add, in the natural air.
in the note, for losed, r. lossed.
§ 97. l. 16. after water, add, be.
§ 101. l. 1. and elsewhere, for soap, r. sope.
§ 111. l. 6. after by, add, agitation, or by
§ 115. l. 24. § 496. l. 2. for niter, r. nitre.
§ 121. l. 4. for temperament, r. temperature.
§ 122. l. 44. after for, r. such as can be.
§ 135. l. 5. after a, add, kind of
§ 142. l. 15. for sc perabundant, r. superabundant.
§ 152. l. 5. for bett r, r. better.
§ 178. l. 24. for to, r. in.
§ 190. l. 20. instead of for, r. to
§ 190. l. 21. for water, r. waters.
§ 209. l. 4. § 212. l. 3. § 213. l. 7. and universally, for heightened, r. highthened.
§ 218. the paragraph following is to be numbered, § 219.
§ 224. l. 32. after fixed, add, especially, in an advanced proportion.
§ 225. l. 15. for these, r. those.
§ 230. l. 12. after if, add, into.
l. 13. after dropped, d. into.
§ 245. l. 14. for cracking, r. crackling.
l. 34. for pelucidity, universally, r. pellucidity.
§ 246. in note; after STAHL, add, &c.
§ 247. l. 8. for fleaks, r. flakes.
§ 251. l. 6. for which, r. that.
§ 287. l. 12. after be, add, partly.
§ 300. l. 2. for su ers, r. suffers.
§ 364. l. 12. for those, r. these.
§ 379. l. 6. for overrun, r. overran.
l. 14. for whereby, r. whence.
§ 382. l. 4. for title, r. titule.
§ 385. l. 14. § 452. l. 17. and elsewhere, for muscles, r. muscules.
§ 389. l. 5. for they be, r. the fluids be.
l. 6. after and, dele are.
§ 391. l. 1. for ofphysiology, r. of physiology.
§ 393. l. 5. before infinitely, r. almost.
§ 395. l. 2 for exceeding, r. exceding.
l 8. after one, add, third.
l. 10. after parts, add, in three.
§ 393. l. 17. § 401. l. 30. and elsewhere, for humours, r. humors.
§ 401. l. 10. and in all like instances, for intolerable, r. intollerable.—as.

§ 401

§ 401. l. 26. for tolerable, r. tollerable.
§ 403. l. 24. for Allum, r. Alum.
§ 404. l. 2. for Schlangenbad, r. Schlangenbadt.
§ 414.. l. 7. for fit, r. fits.
§ 422. l. 14. for, Nor were they fruſtrated in their expectation, r. Nor were their expectations fruſtrated.
§ 425. l. 25. for favour, r. favor.
§ 431. l. 2. after the, r. different.
§ 433. l. 26. for leaſt, r. leſt.
§ 454. l. 28. for vigour, r. vigor.
l. 30. for ARISTOTLE, r. ARISTOTEL.
§ 458. l. 18. for chieflyalcaline, r. chiefly alcaline.
§ 460. l. 17. before impatient, r. is.
l. 22. for prevail, r. prevale.
§ 464. l. 15. for frozen, r. froſen.
§ 464. l. 52. for out, r. our.
§ 472. l. 26. for practitioner, r. practicioner.
§ 505. l. 17. for molified, r. mollified.
§ 506. l. 5. for were, r. was.
§ 518. l. 17. for viſidity, r. viſcidity.
§ 521. l. 5. for frenzy, r. phrenſy.
§ 523. l. 15. § 525. l. 6. and elſewhere, for judgment, r. judgement.
§ 541. l. 2. after and, add, that,
§ 555. l. 6. 14. 17. and elſewhere, for afloat, r. aflote.
§ 557. l. 1. for rheumatick, r. rheumatic.
§ 575. l. 1. after of, add, this kind of.
§ 582. l. 5. for conceal, r. concele.
§ 595. l. 11. before bottom, d. ing.
§ 596. l. 2. after quarts, add, or more

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TO

THAT MOST ILLUSTRIOUS ORNAMENT

TO THE

BRITISH STATE,

THE RIGHT HONORABLE,

The EARL of MACCLESFIELD,

PRESIDENT,

AND

The RIGHT HONORABLE, HONORABLE and

MOST RESPECTABLE,

The COUNCIL and FELLOWS

OF THE

ROYAL SOCIETY;

THESE TRACTS

ARE OFFERED AND SUBMITTED,

AS A PUBLIC TESTIMONY

OF THE MOST PROFOUND RESPECT

AND VENERATION

OF THE

AUTHOR.

TO

THE VERY REVEREND DEAN OF

ST. PAUL'S,

THE RIGHT REVEREND THE LORD BISHOP

OF LONDON,

THE REVEREND THE PRESIDENT AND FELLOWS

OF

THE ROYAL SOCIETY,

THE REVEREND THE PROVOST AND FELLOWS

OF

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THE REVEREND THE MASTER AND FELLOWS

OF

TRINITY COLLEGE, CAMBRIDGE,

THE REVEREND THE PRESIDENT AND FELLOWS

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THE ROYAL ACADEMY OF ART

A

# General Idea of SALTS,

INTRODUCTORY TO

# An Eſſay on WATERS.

§ 1. THE univerſal creation is divided by naturaliſts into three diſtinct claſſes, which they call kingdoms: 1. The mineral, 2. The vegetable, and 3. The animal.

§ 2. 1. By minerals or foſſils, we underſtand all thoſe natural bodies, that compoſe the terraqueous globe, whether found in the bowels, or upon the ſurface, of the earth, having no perceptible organs or veſſels, but owing their generation and formation entirely to ſome external cauſe; ſuch are water, earths, ſtones, mines or ores, metals, ſalts, ſulphur, bitumen, coal and the like.

§ 3. 2. By vegetables, is underſtood a claſs of natural bodies, ſo called, from their perceptible growth, in contradiſtinction to minerals, which can have no vegetation, for want of proper organs. Theſe are hygraulic bodies, conſiſting of an infinite number and variety of veſſels, which contain and circulate different juices or fluids, abſorbed partly by the roots, where-

by they adhere to the earth or other bodies, and thence imbibe their groſſer nouriſhment, the matter of their accretion, and partly from the atmoſphere, by the pores of the leaves, buds or bark. Under this head, are comprehended all herbs or plants, ſhrubs or trees, and their different parts and productions.

§ 4. 3. The animal, ſo called from its having life and motion, is an hygraulic body, which, like the vegetable, is qualified to take in the matter of nutrition and accretion, partly from groſſer ingeſted elements, by veſſels within itſelf, bearing analogy to the roots of vegetables; partly of a more ſubtil kind, from the air by the lungs, or by the pores of the ſkin; and ſubſiſts by a continual determinate motion of fluids, elaborated within itſelf, through certain canals; the ſeveral parts of its body being, at ſome time of its exiſtence, vaſcular.

§ 5. To theſe, ſome add a fourth claſs or kingdom, the atmoſpheric, or meteoric; but this ſeems not very material; ſince all the bodies we find floating in that fluid, may be traced from their original ſource, the earth. However, ſuch bodies as we receive immediately from thence, we diſtinguiſh by theſe names; as meteoric or atmoſpheric ſalts, waters, *&c.*

§ 6. However inconceivably great the number and variety of natural bodies, to all thinking men, muſt appear, the philoſophical chemiſts hold them to be all ſeverally compoſed of certain principles, or material eſſences, not exceeding four in number. Theſe primary eſſences or conſtituent particles of bodies are deemed infinitely ſmall and indiviſible, perfectly ſimple and homogene; endued with certain determinate forms, though from their extreme minuteneſs, imperceptible to our ſenſes; and with certain properties and qualities, as gravity, attraction, repulſion, *&c.*

§ 7. Theſe ſeem to have been confuſedly known, though better conceived than deſcribed, by the antients. All philoſophers have acknowledged, firſt principles or primary eſſences of bodies, under one name or other.

ther. Theſe were the elements of the Peripatetics; the atoms of Democritus; the monades or unitates of Pythagoras and others; the materia prima of Des Cartes, and the hard primary particles of our immortal NEWTON.

§ 8. BECHER has thrown the cleareſt light upon this ſubject. The four principles, he enumerates, are,

§ 9. I. The humido-fluid, or aqueous element;

§ 10. II. The dry denſe principle, which conſiſts of three kinds of earths, as he calls them; theſe are,

§ 11. 1. Terra prima, the primary, or vitrifiable earth; which he looks upon as the baſis or matrix of all other earths, and conceives to be the ſalt principle of the antients, as it is found the true baſis of all known ſalts.

§ 12. 2. Terra ſecunda, φλογιστου, Phlogiſton, the ſecond or inflammable earth or principle, the pabulum ignis, food or fewel of fire; to the antients but obſcurely known, under the name of ſulphur, in the enumeration of the principles of bodies. But, the moderns by this underſtand a perfectly pure and ſimple elementary matter or principle; the cauſe of inflammability, of colors and odors in all bodies: vegetables and animals abound with this principle; ſo doe ſulphur, coal, and all bituminous matter; and no minerals are perfectly exempt from it. It is one and the ſame in the ſubjects of the three kingdoms. No ſubject parts with its phlogiſton in any degree of fire, if air be excluded. Metals deprived of it are reduced to calces, and loſe their metallic ſplendor, fuſibility, ductility, and other properties; upon reſtoring this, they are revived into their priſtine form, with all their properties. To give one familiar inſtance for all. Lead by calcination loſes its phlogiſton, and becomes a red calx or mineral earth. If this be fluxed with any inflammable body, oil, pitch, wax, fat, wood, bone,

or mineral oil or bitumen, it reſorbs the inflammable principle, and becomes perfect lead as before. But, to give an experiment within every perſon's compaſs. Let a red ſealing wafer be ſet on fire in the flame of a candle, and then held over a piece of paper; it will be found as it burns to hiſs and ſparkle, and then little globules of melted lead will drop upon the paper. The reaſon of which is, the wafer is colored with read lead; to this either the burning flower in the compoſition, or the flame of the candle, or both, give what the calx wants to complete or reſtore the metal, the inflammable principle, which this ſhews to be the ſame in all bodies. And this we mean, whenever the inflammable principle, the ſulphureous principle or phlogiſton, is mentioned in this eſſay or elſewhere.

§ 13. 3. Terra tertia, the third or mercurial earth, or metalliſing principle, from which metals derive fluidity, without humidity; by fire, fuſing or running with it, as fluid, yet as dry as mercury or quickſilver; without it, remaining infuſible earths, calces, in the ſtrongeſt fire. This may be the principle, called by others, mercury, or ſpirit. It generally accompanies the phlogiſton, from which it ſeems inſeparable.

§ 14. Should I enter upon the demonſtration of the being and attributes of theſe principles, it would lead me into a diſquiſition too remote from my ſubject, and too tedious to the reader, whom I muſt, for further ſatisfaction, refer to the works of BECHER, STAHL and HOFFMAN. Here, it muſt ſuffice to ſay, that, from different combinations of theſe four principles, or ſome of them, in various proportions and manners, all created beings are held by modern philoſophic chemiſts to be originally produced; and that into ſome or all of theſe principles, all bodies are reducible, by art, as well as nature; and that there is in nature, a conſtant regular ſucceſſion of creation or generation, and corruption or reſolution of bodies throughout the univerſe, from, and into, theſe principles;

ciples; for, the deſtruction of one body becomes the means of generating an other.

§ 15. Thus far I held it neceſſary to give a chemical idea of the diviſion of natural bodies, and a general notion of their creation and reſolution. More does not properly come within the ſcope of my preſent intention, which is only to inquire into the nature and properties of water. But, before I enter upon that ſubject, I ſhall endeavor to explane the nature and properties of ſalts in general, as the principal means, by which water becomes compounded, as well as the chief inſtruments in exploring the compoſition of that fluid.

§ 16. By ſalt, we underſtand a body which is ſapid or ſavory, that is, imprints in ſome degree a ſenſe of corroſion or irritation upon the palate, from its ſolubility, without which it could impart no taſte. Salts therefore in general are ſoluble in water, and fuſible in the fire, and miſcible with ſuch earths as bear affinity to their particular baſe.

§ 17. Every ſalt is looked upon to conſiſt of the aqueous principle, united with the firſt or vitrifiable earth; ſometimes with that alone, and ſometimes compounded with one or more of the terrene principles; whence the great diverſity of ſalts ariſes.

§ 18. The chief criterion of ſalts, their great attraction with, and ſolubility in water, is derived from their firſt principle, the aqueous; and their ready union with ſome other terrene bodies and promoting their ſolution alſo in water, ariſes from the attraction their terrene principles hold with other ſimilar bodies.

§ 19. There is a very great variety of ſalts, which are differently diſtinguiſhed, the one from the other.

§ 20. I. Firſt, they are diſtinguiſhed, from the manner of their production, into natural and artificial, or ſuch as partake of both.

§ 21. 1. The natural, are thoſe, that are found in the natural bodies of the different kingdoms, ſpontaneouſly produced.

§ 22. 2. The artificial, are thoſe, that are extracted or elaborated by art out of any of the natural bodies, by ſolution or elixiviation, by incineration, fermentation, putrefaction, diſtillation or other operation of art; to which may be added,

§ 23. 3. Such as are partly indebted to nature, and partly to art, for their production; as modern nitre, *&c.*

§ 24. II. The ſecond diſtinction of ſalts ariſes from the bodies or kingdoms, whence they are produced or extracted; theſe are 1. Mineral. 2. Vegetable. 3. Animal.

§ 25. 1. Such ſalts, as are found in the earth, or made or extracted from any foſſil body, are called mineral. From this ſource, all ſalts are found to have deduced their origin, however they be ſeen in other bodies altered and diverſified.

§ 26. 2. All ſalts, that are by any means made or extracted from any vegetable body, are diſtinguiſhed by the appellation of vegetable ſalts; as,

§ 27. 3. Thoſe that are drawn from any animal body, are called animal ſalts.

§ 28. III. Salts are likewiſe diſtinguiſhed by their different degrees of permanence or fixedneſs in the fire or open air, into

§ 29. 1. Fixed ſalts, which ſuffer no eſſential alteration in pure air, no loſs of ſubſtance by the utmoſt degree of heat, unleſs flame be reverberated upon them; as all the fixed ſalts, made from the aſhes of calcined vegetables.

§ 30. 2. Volatile ſalts, which are not only ſet in motion and diſſipated by the ſlighteſt heat, but fly off if expoſed to the open air; as ſalts extracted by putrefaction or diſtillation of vegetable or animal bodies, and the like.

§ 31. 3. Semifixed or ſemivolatile, which ſtand the open air, and ſome degrees of heat; yet, by fire, in cloſe veſſels, may be raiſed from the bottom to about the middle or upper part of the veſſel, where it will again run into its priſtine form. Such are the ſalts called ammoniac, and the like.

§ 32. IV. But the moſt material diſtinction of ſalts, for our preſent purpoſe, and that which beſt deſerves our preſent attention, is their diviſion into, 1. Acid, 2. Alcaline, and 3. Neuter ſalts.

§ 33. 1. The acid ſalts are known to all by the taſte; which is alſo called in our language, ſour, and are common throughout the whole face of nature; they are denominated from the ſeveral kingdoms whence they are drawn, 1. Mineral, 2. Vegetable, and animal.

§ 34. 1. The mineral acids are threefold;

§ 35. The firſt is that vulgarly denominated from the mineral ſubſtances whence it is moſt commonly extracted, the acid of ſulphur or vitriol or alum, generally known by the names of ſpirit, or oil of vitriol or ſulphur. This is the univerſal acid, that pervades the whole creation. It is called aerial and ætherial, from its abounding in a volatile form, in theſe regions; and primogenial, from its being the original ſource, from whence all other acids ſpring. This is judged to be compoſed ſimply of the aqueous principle and the firſt, or mineral vitrifiable earth, united. This is found either volatile or fixed, in nature, as well as by art.

§ 36. The ſecond is the acid of nitre, vulgarly called ſpirit of nitre, or aqua fortis. This is by art extracted from the ſubject, whoſe name it bears, modern nitre or ſalt-petre, and is judged to conſiſt of the firſt, the univerſal acid, moſt ſubtilly attenuated by the phlogiſtic or inflammable principle, by the means of putrefaction. It is never found pure in nature; being always found adherent to ſome terrene or ſaline

baſe. Wherefore, in this form, it is ever to be looked upon as a creature of art.

§ 37. The third is the acid of ſea ſalt, called alſo vulgarly its ſpirit. This is extracted from the ſubject whoſe name it bears, by the ſame means as the acid of nitre is drawn; and is judged to conſiſt of the univerſal acid, ſubtiliſed by its union with the third earth, or mercurial principle; whence its aptitude to volatiliſe certain metals and metallics. This is never found pure in nature, more than the acid of nitre; but, like that, is found united in its proper ſubject with a mineral alcali, or like the acid of nitre, with a calcarious baſe: ſo that, like the preceding, in this form, it is to be looked upon as a child of art.

§ 38. 2. The ſecond general claſs of acids is the vegetable. Theſe are either, 1. Native, or, 2. Artificial.

§ 39. 1. The Native acids are the juices of various plants, as well as fruits; ſuch as thoſe of the dock and common ſorrel kind, as well as wood-ſorrel and others; thoſe of berberies, gooſeberries, corinths, cherries, apples, pears, oranges, lemons, and the like. To which may be added, thoſe acid liquors, which by diſtillation, in a naked fire, are obtained from moſt vegetables, eſpecially the hard woods. Theſe are all judged to ariſe from different combinations with, or modifications of, the univerſal acid.

§ 40. 2. The Artificial acids are thoſe obtained, by the means of fermentation, from the ſweet, as well as auſtere and other taſted, juices or infuſions of vegetable productions; as cyder, perry, wine, mead, beer, and the like; or thoſe, from theſe produced by the ſecond ſtage of fermentation, vinegar; to which may be added, that acid ſaline concretion called tartar.

§ 41. 3. The third general claſs of acids are thoſe, called animal. Such are the gaſtric juices of moſt animals, as rennet; and the acid, which, by waſhing or diſtillation, may be obtained from all inſects armed with ſtings, particularly ants. To which may be added, the acid demonſtrated by HOMBERG in the diſtillation

tillation of blood, and that from urine in the native ſalt *, the baſis of phoſphorus.

§ 42. 2. The alcaline ſalts, ſo called, from having been firſt extracted from the herb kali, to which al being prefixed implies no more, than the article ὁ, ἡ, τὸ, of the Greeks, le or la of the French, or the, of our language; as if one ſhould ſay, the kali or the glaſs-wort. Theſe have a taſte the reverſe to that of acids, with which they do not mix without a contraſt and ebullition, and upon mixture generate neuter ſalts. The alcaline ſalts are,

§ 43. Firſt, fixed; which may be diſtinguiſhed into Native or Mineral, and Artificial or Vegetable. The Native or Mineral alcali is the baſis of common ſalt, the nitre of the antients, not unlike the ſoda or kelp of the moderns, or the alcaline ſalt found in moſt mineral waters. The Artificial or Vegetable alcali is that, which is obtained by the incineration or calcination of any herb, ſhrub, tree, or other vegetable production; except ſuch as yield a volatile alcali; theſe afford no fixed ſalt; and the marine and ſubmarine plants, whoſe ſalt is of the nature of the native or mineral alcali. To this claſs belongs that faſhionable medicine, to which a whimſical and unmeaning name is given, Æthiops vegetabilis: this, called by whatſoever name it may, is none other than ſoda or kelp, the alcali of the antients. Fixed alcalies are judged to be compoſed of the vegetable acid, with a ſmall portion of phlogiſton united with the vegetable vitrifiable earth.

§ 44. Secondly, volatile alcalies; theſe are obtained by putrefaction, or combuſtion of all vegetable and animal bodies, by diſtillation of ſome vegetables, ſuch as the creſs, radiſh and muſtard kinds, the onion tribe, *&c.* that of ſoot, and that of all animal bodies in general. And is ſuppoſed to conſiſt of a ſaline ſubſtance, ſubtiliſed by the union of the inflammable principle, chiefly by means of putrefaction or fire. But there is, beſides this artificial, a natural kind of volatile alcali,

* See J. A. Schlosser, M. D. Leyd. Diſſert. inaugural. de Sale nativo Urinae. Lugd. B. 1752.

attributed

attributed to the place whence it is obtained, the mineral kingdom. This is of too volatile a nature to be found pure alone; it is always united or incorporated with mineraliſed vegetable or animal bodies; ſuch as different petrifications of thoſe ſubſtances. Some doubt its exiſtence in nature; but, with what propriety may be judged from the native ſal ammoniac, which like the artificial, conſiſts of a volatile alcali, and the acid of ſea-ſalt.

§ 45. 3. Neuter ſalts are thoſe that are compoſed of acids and alcalies, but partake of the nature of neither; being a third ſubſtance, reſulting from the mixture, which is of a middle quality, quite neuter; whence they are called ſalia neutra, media and enixa. Of theſe there is an almoſt infinite variety, from combinations of all the different acids with all the various alcalies, as ſhall be further explained in the ſequel. To theſe ſome add the ſaline concretions reſulting from the ſolutions of various earths and metals in acids, calling them compound, terrene, or metallic ſalts, but with impropriety.

§ 46. Omitting various circumſtances in theſe bodies, which relate to natural hiſtory, and natural philoſophy in general, to chemiſtry in particular, I ſhall procede to thoſe properties of ſalts, which more immediately relate to our preſent purpoſe. And

§ 47. 1. With reſpect to the acids; theſe all readily unite with water, becauſe they all abound with that principle: for, by accurate obſervations of Homberg and Boerhaave, the ſtrongeſt and heavieſt acid, the moſt concentrated oil of vitriol, does not contain above one half genuine acid, the other being entirely water. Spirit of nitre conſiſts of ſomewhat above one fourth of pure acid, and ſomewhat leſs than three fourths water. Spirit of ſea-ſalt contains better than a ſixth of the acid, the reſt is pure water. And in one ounce of diſtilled vinegar, there are but about eighteen grains of acid, the reſt is water.

§ 48. Acids, from the attraction between their terrene baſe and other earthy bodies, diſſolve and unite with

with various earths, according to their different degrees of affinity. As ſolvents, they all act with different force and effects upon fixed and volatile alcalies, upon the groſſer earths, ſofter ſtones, and the ſhells of fiſhes. They all moſt ſtrongly attract, and conſequently ſooneſt diſſolve or unite with, 1. the fixed alcalies, and of theſe, the vegetable, rather than the mineral; 2. the volatile alcalies; 3. the abſorbent earths, and of all others quicklime; 4. after that, egg-ſhells; 5. crabs eyes; 6. and laſtly, chalk.

§ 49. Moſt metals, and metallic ſubſtances, are likewiſe in different manners and degrees affected by theſe acids.

§ 50. All the acids, whether mineral or vegetable, are more or leſs capable of diſſolving zinc or ſpelter, and, in ſome manner, lapis calaminaris, or cadmia; in our language calamine, calamy, or cadmy.

§ 51. The vitriolic acid is by itſelf capable of diſſolving not only zinc, but iron and copper; and, with ſome management of art, to which nothing in nature is yet found analogous, quickſilver, ſilver, tin, lead, and regulus of antimony.*

§ 52. But, the order of attraction, and general diſſolving power of this acid, ſtands thus; 1. with the inflammable principle; 2. with fixed alcalies; 3. with volatile alcalies; 4. with abſorbent earths; 5. with zinc; 6. with iron; all which it attacks with ſuch force and rapidity, as to diſſolve them with eaſe and ſpeed; 7. then ſlowly and difficultly copper, and not without peculiar management; 8. lead; 9. quickſilver; 10. ſilver; 11. tin; 12. regulus of antimony; wherefore we find no natural ſolutions of theſe, 8, 9, *&c.* in this acid.

§ 53. The nitrous acid diſſolves, together with the incomplete metals, zinc, quickſilver, regulus of, but not crude, antimony, all the metals complete and perfect; except gold.

§ 54. But, the order of its attracting and diſſolving power, ſtands thus; after the alcaline ſalts and terrene

* Stahl de ſalibus.

ſubjects,

ſubjects, which it affects in much the like manner and order as the preceding acid, it moſt readily attracts and diſſolves, 1. zinc; 2. iron; 3. copper; 4. lead; 5. quickſilver; 6. ſilver; 7. tin; 8. regulus of antimony. But, as this acid is never found pure in nature, we are not to look for any natural ſolution of theſe metallic ſubſtances in this acid.

§ 55. The acid of ſalt attacks and diſſolves the alcaline ſalts and terrene ſubſtances, in common with the other acids, and likewiſe the metals, complete and incomplete; but in a different order and manner from the others; 1. it moſt readily diſſolves iron; 2. more readily than the vitriolic acid, diſſolves copper; 3. tin; 4. regulus of antimony; but, 5. more tardily and difficultly, lead; and 6. moſt difficultly, ſilver; 7. quickſilver, and united with the nitrous acid, when it conſtitutes the ſolvent called aqua regia, not otherwiſe, it diſſolves gold. Yet ſome of theſe metals and metalics, with which it is ſuppoſed to correſpond, in the conſtituent terrene, the mercurial, principle, it cannot diſſolve, unleſs in the concentrated ſtate, or when they are firſt divided or diſſolved by other ſolvents. Thus it precipitates ſilver and lead diſſolved in the acid of nitre, unites moſt intimately with the magiſteries, and renders them volatile; it precipitates mercury diſſolved in the ſame acid, but ſoon after rediſſolves it; and being in the concentrated ſtate united with tin, regulus of antimony, or quickſilver, it renders them likewiſe volatile or ſemi-volatile.* The order of its attraction, as determined by M. Geoffroy in his table of affinities, ſtands thus; 1. tin; 2. regulus of antimony; 3. copper; 4. ſilver; 5. quickſilver; and---8. gold. But, it muſt be remembered, that the abſorbent earths, as well as the fixed and volatile alcalies, precipitate theſe bodies, diſſolved in this ſolvent; and particularly mercury ſublimate, which, with the fixed alcali, gives a brown orange colour, with the volatiles a very white magiſtery. It is alſo to be remembered, that

* § 37.

this

this acid, no more than that of nitre, is found diſengaged from an alcaline or terrene baſe in nature; and that therefore we are not to look for metallic ſolutions in this acid, more than in that of nitre, ſpontaneouſly or naturally.

§ 56. In all theſe caſes, the firſt in the order is reckoned to ſtand firſt in the claſs of affinity, or attraction, with the ſolvent. The firſt then, interpoſing between the ſolvent and the ſecond, will diſſolve the union, cauſe a ſeparation and precipitation of the ſecond, or leſs attracted, and take its place. Thus will the ſecond precipitate or ſeparate the third, the third the fourth, and ſo on; as ſhall be further explaned in giving the method of examining waters by precipitation. See the trial and choice of waters.

§ 57. Let us next conſider the effects produced by the unions of theſe different ſalts, the one with the other, or with divers terrene and metallic bodies.

§ 58. All the acids attack all the alcaline ſalts and abſorbent earths, and the mineral acids in particular, moſt metals, with ſuch rapidity, as to cauſe an effervescence, with a frothy ebullition; but differing in degrees. When the conflict ceaſes, and is not revived upon the addition of new matter, the point of ſaturation is ſaid to be hit, and the ſolvent is then charged with as much of the ſolvend, as it is capable of ſuſtaining in a ſtate of perfect ſolution and neutrality.

§ 59. From theſe ſolutions, different taſtes and other qualities ariſe. All the acids, upon being charged with alcaline ſalts, or abſorbent earths, lay aſide their acid taſte and corroſive quality, and put on a ſaline taſte, with more or leſs bitterneſs, and become inoffenſive to the taſte or touch. Theſe are neuter ſalts.

§ 60. To this there is one exception; the vitriolic acid charged with a certain earth, of the limo-cretaceous kind, conſtitutes that auſtere, rough ſtyptic, called alum.

§ 61. The ſame acid, with iron, yields a mild, ſweetiſh ſtyptic; with copper, a ſeptic; and with mercury, a cauſtic.

§ 62.

§ 62. The acid of nitre, with lead, affords a ſweetiſh ſtyptic; with copper, quickſilver and ſilver, ſeptics and cauſtics.

§ 63. The acid of ſalt, with iron, conſtitutes a ſtyptic; with regulus of antimony, a powerful ſeptic; and with mercury, a formidable cauſtic.

§ 64. All the mineral acids, with all the alcaline ſalts, run into ſalts of certain and determinate cryſtaline forms, and may be ſo kept of a dry and ſolid conſiſtency: whereas, with all the abſorbent earths, they either retain their liquid form, or, being by force of fire reduced to a dryneſs, they attract the humidity of the air, and deliqueſce or run liquid again; except the vitriolic acid, with lime, chalk, or other calcarious earth; and the baſis of alum, with which it preſerves a dry and ſolid form in the ſelenite, as well as in the alum.

§ 65. The vitriolic acid, with fixed, native, or mineral alcali, forms the neuter ſalt we find in moſt mineral waters, which is analogous to Glauber's or Epſom ſalt; with the fixed, artificial, or vegetable alcali, tartar vitriolate; with volatile alcalies, Glauber's ſecret ſalt ammoniac; with all the metals, it is capable of diſſolving, it forms a dry, cryſtaline ſubſtance, eſpecially with iron and copper, which gives us the green and blue vitriols of theſe metals; but this is only to be underſtood of the groſſer or heavier vitriolic acid: that, which is ſubtiliſed and volatiliſed, retains the principal properties of the heavier or more fixed; it preſerves its affinity or attraction, diſſolves metals, earths, and ſalts; but is ſo volatile, as to fly off and quit every body, with which it ever united, upon additional heat, or the interpoſition of the heavier acid; except that, with which it has the ſtrongeſt attraction, the phlogiſton, with which it moſt firmly and intimately unites, and forms that ſemi-volatile concrete, called ſulphur or brimſtone. From the ſolutions of iron, wrought by the means of this volatile acid in the mineral waters, it readily flies off, leaving the iron to precipitate in the form of a martial earth.

Hence

Hence aroſe the falſe notion of a volatile vitriol, ſo univerſally, ſo abſurdly prevalent.

§ 66. The acid of nitre, with the mineral fixed alcali, gives a kind of nitre, whoſe cryſtals are quadrangular; with vegetable fixed alcalies, gives pure nitre, of which a vegetable alcali is the baſe; this is called regenerated nitre. It likewiſe unites and gives a ſaline concretion with the volatile alcali, which is hardly reduced to a cryſtaline form, and partakes partly of the nature of ſal ammoniac, partly of nitre. This acid, with ſilver, quickſilver, and lead, runs into firm cryſtals; but with iron, copper, and tin, it preſerves its liquid form, unleſs the humidity be ſeparated by force of fire; ſoon after which, it reabſorbs from the air enough to liquefy itſelf again.

§ 67. The acids, with the pure alcaline ſalts and abbent earths, cauſe no remarkable change of color; but, with the metals, various differences ariſe.

§ 68. The acid of vitriol, with iron, gives a dark graſs-green, brighter in its cryſtals; with copper, a bright ſapphirine blew, deeper in its cryſtals.

§ 69. The acid of nitre, with iron, produces a color between yellow and a rediſh brown; with copper, a pale or ſky-blew; with ſilver no color, except when it is allayed with copper; then it acquires the color proper to this metal.

§ 70. The acid of ſalt, with iron, produces a color between a yellow and a green; which ſolution, upon ſtanding, depoſites a blackiſh ſediment; which, upon the addition of new ſpirit of ſalt, tinges a kind of orange color. This acid, with copper, gives a bright emerald color, which by time becomes more and more obſcured with brown. If this acid be mixed with the nitrous acid, in any proportion, it conſtitutes aqua regia, in which copper diſſolved gives a green, and gold, its natural color.

§ 71. The forms of the cryſtals produced by theſe combinations, ſufficiently characteriſe them.

§ 72. The

§ 72. The cryſtals reſulting from the ſaturation of the vitriolic acid with any fixed alcali, conſiſt of eight ſides, and terminate in obtuſe or broken pyramidal points. Such are the cryſtals of tartar vitriolate, *&c.* And theſe are infuſible, ſtanding the fire unaltered. Thoſe ariſing from the union of this acid with the mineral alcali, or baſe of ſea-ſalt, bear a different aſpect, which makes them an exception to this rule. They nearly approach to the figure of the hexagonal priſms, which nitre affords; but that they chiefly cryſtaliſe horizontally in the liquor; whereas the cryſtals of nitre run in all directions. This ſalt is exceeding fuſible.

§ 73. The cryſtals of vitriol of iron are of the figure, called parallelopiped; the ſides and angles ſtanding oppoſite to each other.

§ 74. Cryſtals of vitriol of copper exhibit the like form; but the ſituation of the ſides and angles, with reſpect to each other, are more uncertain and indeterminate.

§ 75. The cryſtals, ariſing from the ſaturation of the nitrous acid with any artificial fixed alcali, exhibit the ſame form with thoſe of nitre, hexagonal priſms, whereof two oppoſite ſides excede the reſt in equality of ſurface, as well as in breadth; each priſm terminating in ſuch a point, as any of the cryſtals cut obliquely, tranſverſly, from one broad ſide to its oppoſite, would expreſs. This is nitre regenerated. But the ſame acid, ſaturated with the native alcali, yields quadrangular cryſtals.*

§ 76. This acid gives different cryſtals with the different metals ſoluble in it, which are reducible to a cryſtaline form. Thus with lead, it forms cryſtals of different figures, from eleven to twenty ſix ſides; whereof one, which is the under ſide, is broad and flat, the reſt cut into various ſides of various forms, upon an hexagonal and ſometimes upon an octagonal

* § 66.

baſe;

baſe; with ſilver, thin, flat, and indented plates or ſcales are formed; with quickſilver, pointed, ſpear-formed cryſtals; and with ſilver and quickſilver together, ſhrub or tree-formed cryſtalline concretions, the much talked of Diana's or the philoſopher's tree, are produced.

§ 77. The acid of ſea-ſalt, ſaturated with either the vegetable or the mineral fixed alcali, which is its proper baſe, gives cryſtals, which are commonly, but improperly, called cubical: for, they are compoſed of ſmall ſquare pieces of equal lengths, which, uniting at the extremities, form a true ſquare figure; from this, another ſquare, of a ſmaller ſize, iſſues; to this, a third adheres, and ſo on to a fiveth or ſixth, always diminiſhing till it ends in a ſeeming cubical figure. Thus every cryſtal of ſalt is formed from the firſt larger, which is the pellicle, to the laſt or loweſt; and ſo forms an inverted pyramid. This is the regeneration of ſea-ſalt. But, with a volatile alcali, with which it conſtitutes ſalt ammoniac, it yields long, ſlender, plume-formed cryſtals.

§ 78. Let us now conſider theſe mineral acid ſalts, with reſpect to their different powers of attracting, diſſolving, and holding bodies in ſolution.

§ 79. It is found, by experience, that the vitriolic acid engages any alcaline ſalt, and retains it more firmly, than that of nitre or ſalt does the ſame baſis. The attraction then of this acid to a fixed alcali, is ſtronger than that of nitre; and that of the acid of nitre, to the ſame baſe, is ſtronger than that of ſalt; the acid of ſalt is ſtronger than that of vinegar, and ſo on.

§ 80. Theſe poſitions are at once explaned and proved, by the following experiments:

§ 81. 1. Let the acid of ſea-ſalt be ſaturated by the addition of a ſufficient quantity of a fixed, vegetable alcali, and a ſalt in moſt reſpects correſponding with

ſea-ſalt will be generated. This proves the conſtituent parts of ſea-ſalt to be this ſpecific acid, and an alcaline, ſaline baſe. The reſult of this compoſition is called, regenerated ſea-ſalt.

§ 82. 2. To this ſalt, in a glaſs retort, let the acid of nitre be added; this will more ſtrongly attract, and be attracted by, the alcaline baſe of the firſt ſalt, than that was by the lighteſt and weakeſt of the mineral acids, that of ſea-ſalt; whence, upon adminiſtering the proper degrees of heat, the acid of ſea-ſalt will diſtil in white fumes, not quite free from the very volatile red fumes of the nitrous acid. This will be a kind of aqua regia, the acid of ſea-ſalt, with ſome portion of the nitrous acid. In the retort will remane a white ſaline maſs, conſiſting of the nitrous acid united to a fixed vegetable alcaline baſe; this, by ſolution, evaporation, and cryſtalliſation, yields regenerated nitre, perfect ſalt-peter.

§ 83. 3. If to this ſalt, in another retort, a ſufficient quantity of the vitriolic acid be added, this will ſeiſe the alcaline ſalt, that alternately ſerved for a baſe to each of the preceding ſalts; and, the nitrous acid being thus ſet free, it will readily diſtil, as the acid of ſea-ſalt did before. And now we have the alcaline baſe united with the vitriolic acid, which by cryſtalliſation gives us tartar vitriolate. An infuſible ſalt, which can only be decompoſed, by the intromiſſion of the inflammable principle.

§ 84. Thus, the heavier and ſtronger, expels the weaker and lighter acid. Theſe experiments ſhew us, how the more potent acid ſerves to propel the weaker: for, as the acid of nitre ſupplants and propels the acid of ſalt, and as the vitriolic acid propels each of the others; ſo any of theſe mineral acids, propels any of the vegetable acids, that can unaltered bear the operation, from an union with the like baſe. Had the common ſea-ſalt, with its own mineral

alcaline

alcaline baſe been uſed, the reſult, as to the acids, had been the ſame; but, as to the remaning ſalts, they would have differed: for, from the firſt, the ſaturation of the acid of ſea ſalt, with the native fixed alcali, we ſhould have had true ſea-ſalt; from the diſtillation of that ſalt with the nitrous acid, quadrangular nitre, and from this and the vitriolic acid, Glauber's ſalt.

§ 85. From theſe experiments, the different attractive powers of theſe ſeveral acids to the ſame baſe appear, and the means of breaking their coheſion or union is ſhewn; all to that of the vitriolic acid to the fixed alcali. This is onely to be done by the addition of any phlogiſtic body, and fuſing it with Glauber's ſalt or with vitriolate tartar, and ſome fixed alcali to promote the fuſion of that otherwiſe infuſible ſalt. By this, a ſeparation of the vitriolic or univerſal acid from the alcaline baſe is effected; and a new combination of the univerſal acid with the inflammable principle is produced, which gives ſulphur or common brimſtone, which ſhall be further ſpoken to in giving the method of examining waters. But, this vitriolic acid, the heavieſt and moſt fixed, may be rendered the moſt ſubtil and light of all others, by the union of a certain portion of phlogiſton with it. Thus, vitriol diſtilled in a cracked retort, the acid is ſubtiliſed and volatiliſed. The like is obtained by diſtilling any eſſential oil or ſpirit of wine with oil of vitriol, and by diſtilling pyrites. This kind of acid unites with alcalies and abſorbents, and even with metals for a while; but readily quits them, eſpecially upon the ſlighteſt, increaſed heat, or the interpoſition of an heavier acid. And this is the volatile acid, with which moſt medicated waters are charged, and which is falſely looked upon as a volatile vitriol.

§ 86. 2. As to the alcaline ſalts, it may be neceſſary to give ſome further intimations of their properties, and diſtinguiſhing characteriſtics.

§ 87. As acids are the proper ſolvents of earths and metals, as well as of alcaline ſalts; ſo alcalies break theſe connections, precipitate earths, ſtones, or metals diſſolved in acids, and alſo become the proper ſolvents of mucilages, gums, reſins, gummi-reſins, and oils of vegetables, both the expreſſed and diſtilled, as well as of the fats and oils of animal bodies. On the other hand, by means of alcalies, ſome incomplete, as well as complete, metals are diſſolved; lead, tin, antimony, *&c.* deflagrate with nitre, and are thereby reduced to a calx. In this caſe, the nitre is in part alcaliſed and charged with the metal or metallic. The alcaline ſalts thus charged diſſolve in water; whence, the ſolid contents diſſolve in water, and are precipitated by acids. And copper and iron diſſolved in acids, are wreſted from them and held diſſolved by alcalies.* So likewiſe ſulphur, and various ſulphureous concretes of the mineral kingdom, readily unite with alcalies, and by their means become ſoluble in water, burning ſpirits, and in oils, eſſential and expreſſed.

§ 87. Alcalies likewiſe diſſolve in burning ſpirits, into a kind of ſaponaceous fluid, and give them an orange-colored tincture; eſpecially the fixed, which ſucceed the better the more cauſtic they are rendered by calcination, which they bear with little or no alteration or loſs for a great length of time; unleſs the flame be reverberated upon them, which will in ſome ſort volatiliſe them. Spirits thus charged with alcalies are not to be perfectly freed from them, even by repeted diſtillation. Such are commonly called tartariſed, but properly, are alcaliſed, ſpirits.

§ 88. All the alcalies change the juices of blew and red flowers, and the red juices of certain plants into a green; and the more acrid and pure the alcali, the higher and brighter the green. Blews obtained from certain putrefied plants or vegetable juices, ſuch as

* § 231, 233.

archil,

archil, tournſol, *&c.* have their colors exalted or preſerved by alcalies, eſpecially the volatile; and when tinged red by acids, alcalies will reſtore them to their priſtine color, or give them a purple or violet hue.

§ 89. Alcalies, readieſt of any ſalts known in a concrete form, diſſolve in water. They may then be taſted, which their extreme acrimony and cauſticity, before ſolution, renders unſafe. They then imprint upon the tongue an urinous, acrid taſte. Such a ſolution is known, 1. by cauſing an ebullition upon mixture with acids, and thereby yielding a neuter ſalt; 2. by changing the colors of certain vegetable juices, as juſt now mentioned *; 3. by precipitating metals and earths diſſolved in acids; 4. by precipitating a ſolution of mercury ſublimate in water, of an orange-color, by the fixed, and of a white, by the volatile, alcalies.

§ 90. The different degrees of ſolubility of ſalts in general, and the manner of ſeparating them from groſſer earths, as well as from each other, ſhall be ſpoken to in ſhewing the diſſolving powers of water.

§ 91. This general ſketch of the generation or production of ſalts, the more ſimple, as acids and alcalies, as well as the more compound, ſuch as the neuter, terrene, and metallic ſalts; together with their relation to each other, and to various other ſubjects; their powers as menſtrua or ſolvents, and their effects in producing, deſtroying, and reſtoring or reviving colors, and in cauſing various precipitations in different ſolutions, ſhall be enlarged and further inſiſted on and explaned, as far as it relates to the preſent purpoſe, in treating of the method of trying or examining waters, to which the reader, for further particulars, is referred.

* § 88.

§ 92. The preceding experiments and obſervations ſhew us, as far as may be expected in a work of this nature, how the various kinds of ſalts are generated, and how the great variety of ſolutions and combinations of bodies capable of being ſuſpended in water, which are by the means of different ſalts found in the univerſe, may be produced and diſcovered.

*The End of the general Idea of Salts.*

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AN

# ESSAY

ON

# WATERS.

## PART I.

### *Of* WATER *in general.*

§ 1. THE element, which the Greeks knew by the name of ὕδωρ, Hudoor, the Latins by that of Aqua; that which the Germans call Waſſer, the French l'Eau, and which in our language is called Water, is a liquor ſo univerſally known, to the rational and irrational animals of the creation, that to the one, the idea is determined by the bare name; to the other, by the ſenſes, upon ſeeing, feeling or taſting.

§ 2. Yet, notwithſtanding this general knowledge of water, nothing ſeems more wanting, or more difficult to be obtained, than a true and rational notion of this moſt beneficent fluid.

§ 3. I ſhall not, in this place, treat of water as a mere element, or one of the phyſical principles or conſtituent parts of other bodies; I ſhall chiefly conſider it as it occurs to our ſenſes, and examine its natural appearances and principal properties, qualities and uſes. And, for better diſtinction, I define it,

§ 4. An humid, fluid, pellucid, colorleſs, inodorous, inſipid body; lighter than earths; heavier than air, moſt * oils and burning ſpirits; incompreſſible; uninflammable; but, by heat, capable of great rarefaction and extreme expanſion, with remarkable elaſticity; and by cold, ſubject to conſolidation in congelation or freeſing. Its conſtituent parts are very heterogene; for, with the ſubtil elementary fluid, pure water, all the other elements, in various forms, as different earths, ſalts, ſulphureous, or inflammable bodies, and air, in greater or ſmaller proportions, and more laxly or intimately blended, are always combined.

§ 5. Though, according to this definition, there be but one kind of water; yet, for greater clearneſs and certainty, we diſtinguiſh it into ſeveral kinds, from the different matters, that appear to predominate in the fluid.

§ 6. Hitherto, there has not been diſcovered, in nature or by art, a water perfectly pure, truly elementary. Yet notwithſtanding, as we are forced to judge of things in general relatively or comparatively, ſo do we judge and ſpeak of waters: ſuch then, as are found to exhibit nothing ſenſible to the ſmell or taſte, and are by all agreed to be clear, colorleſs, inodorous and inſipid, are, by common conſent, called pure or ſweet waters; whileſt ſuch, as ſtrike the ſenſes with ſomething remarkable in color, ſmell or taſte, are called mineral or medicinal waters.

§ 7. But, it is found neceſſary to be ſtill more particular in theſe diſtinctions.

§ 8. The ſcriptural hiſtory of the creation teaches us to divide the waters into two general claſſes. We are there told of the ſeparation of the waters from the waters. Whereby, not only this globe of earth was

* There are ſeveral oils ſpecifically heavier than common water; as the empireumatic oils of guajacum, box, *&c.* and even the eſſential oils of cloves, cinnamon, ſaſſafras, *&c.*

copiouſly

copiouſly furniſhed with waters, but the heavens, or circumambient air, was ſo charged with this element, as to be able to render the earth new ſupplies of purified water upon various emergencies.

§ 9. Thus we find not onely the earth plentifully ſtored with water, ſo as to be thence called the terraqueous globe, but the ſurrounding atmoſphere alſo is every where abundantly charged with this fluid. And theſe two different depoſites or collections hold a continual mutual intercourſe with each other, by a ſort of diſtillation.

§ 10. For, the waters of the earth are rarefied, attenuated and divided by the heat of the ſun and other fires, into particles ſpecifically lighter than the air; whence they ariſe in viſible vapors or inviſible exhalations, and float in the air; until, condenſed by colds, they are again returned in form of dew, rain, ſnow, froſt, *&c.*

§ 11. By this means, not onely a continual purification of the waters is carried on, but a perpetual circulation or diſtribution of them is brought about. The mountains and other high grounds, which, by the ordinary laws of nature, could receive no ſupplies from the immenſe collections of water on the face of the earth, are furniſhed occaſionally from the atmoſphere. And, when the various terrene productions, that require it, are ſufficiently ſupplied with humidity, the redundance is ſent towards the common repoſitory in the conduits of ſprings and rivers.

§ 12. Theſe conſiderations naturally teach us to diſtinguiſh waters into,

I. Meteoric, or atmoſpheric; and,
II. Terreſtrial.

§ 13. I. The meteoric or atmoſpheric are onely the humid vapors and exhalations raiſed from the terraqueous globe, for a while carried about in the air, and by cold condenſed into it's priſtine form. Theſe are for

for the moſt part the ſweeteſt and pureſt waters, with which nature furniſhes us. But, as they paſs through the air or atmoſphere, a body as compound, as water can well be imagined, they are never to be looked upon as perfectly pure; they muſt partake of whatever they are capable of diſſolving in the medium, through which they have paſſed.

§ 14. The different kinds of meteoric waters are,

§ 15. 1. Dew: This is a humid vapor raiſed from the earth in the day time, by the heat of the ſun, and as that declines, falling back again upon the ſurface of the globe, and condenſing into water. This is deemed of all others the moſt light and ſubtil water. And, could it be collected at diſtance from great cities, and in receptacles, that could make none impreſſion upon it, it might be accounted the moſt pure of any. But, it varies not onely according to the air, through which it paſſes in its aſcent and deſcent, but is affected alſo by the plants, from which it is gathered. So that it is always difficult to get pure dew. And the pureſt is not to be conſidered, in ſtrictneſs, as pure water. It is very ſubject to fermentation and putrefaction.

§ 16. 2. Rain water: This comes neareſt to dew in levity, ſubtility and purity. It is raiſed from the ſame fund by the ſame means, into the atmoſphere; where it is preſumed to ſojourn longer than dew, which is probably the product of one and the ſame day. Conſequently, rain muſt be more ſtrongly and variouſly impregnated with whatſoever is found capable of floating in the atmoſphere, than dew, which has made a ſhorter circuit. For this reaſon, dew has been but rarely obſerved much altered, except by the body, from which it has been gathered; but, rain has been found charged with every thing, that is by any means ſuſpended in the air. Thus, rain has been obſerved to bring with it various and innumerable products, not onely of the vegetable and animal creation, but alſo of the mineral kingdom; even iron, if we may credit what

what our Gilbert *, in his treatiſe on the magnete, cites from Avicen, Cardan, Scaliger and Cicero, concerning iron ſhowers; which will appear leſs ſurpriſing, when we come to explane the cauſe of heat in baths. Since rain in its fall muſt waſh the atmoſphere, which is a moſt compound body, always varying with the climate and ſeaſon of the year; it is eaſy to comprehend where and when it is to be had moſt pure. The farther it is collected from cities or other inhabited places, in other words, the clearer and purer the air, where rain is collected, the purer and ſimpler the water muſt be. In like manner, thoſe ſeaſons of the year, in which moſt exhalations ariſe from the earth, are thoſe, in which it is moſt compounded, and ſo *vice verſa*.

§ 17. But, ſo far is the beſt rain water from purity, that it conſtantly ferments and putrefies upon long ſtanding, eſpecially in a warm place. If then diſtilled, it yields an oily, and in ſome meaſure, inflammable ſpirit; which, being concentrated by frequent deſtillations, is ſaid to become a proper ſolvent for gold †.

§ 18. HIPPOCRATES perfers rain to all other waters ‡. He recommends that, which falls from bright white clouds in ſummer; eſpecially after thunder and lightening, by which the air is purified or freed from much ſulphureous matter. He rejects rain, that falls from thick, dark, black clouds. And, in general, recommends the boiling of rain water before it be applied to internal uſe; as it is of all others the moſt liable to corruption. Rain water kept for ſome time, eſpecially in warm weather, ſhews firſt its containing the ſmall ſeeds of various minute plants; which firſt vegetate in it, then render it mucilaginous, and cauſe it to ferment. At the ſame time, it appears charged with the egs of various animalcules, which being

* Phyſ. de Magnete, lib. 1. c. 8.
† Act. Leipſ. an 1690. p. 86.
‡ Epidem. lib. 6. & De Aquis.

hatched

hatched in it, ſoon after cauſe it to putrefy. Hence the caution of the divine old man is wiſe and juſt.

§ 19. 3. Snow, hail, froſt or ice. Theſe are by moſt diſtinguiſhed from each other; though I cannot ſee with what propriety; ſince they are all but water in different manners and forms congeled, or by cold reduced to more or leſs of a dry and ſolid conſiſtency and form.

§ 20. The pureſt and ligheſt waters are moſt apt to congele or freeze. And all waters, by whatſoever means congeled, are thereby rendered more free from foregne matter of all kinds. Snow and hail may be gathered without being ſenſibly affected by any dry bodies, on which they fall. And ice thawed depoſites ſuch terrene parts, as before adhered to the water.

§ 21. Snow, hail, *&c.* have the ſame origine with rain or dew, and tend to the ſame end. The humid vapors and exhalations riſing from the earth, which are but water ſo rarefied and divided, as to be made capable of floating, or being ſuſpended in the air; by one degree of cold, are rendered ſpecifically heavier than the air, in which they were but juſt now ſuſpended; whence, they neceſſarily preponderate; but in thoſe minute and almoſt imperceptible particles, which are called dew. Such of theſe vapors, *&c.* as are raiſed higher, in the region of the air, are carried about according as the air is put in motion; until, by a certain degree of cold, they are again condenſed into water, and ſo deſtil in rain. And an higher degree of cold converts this into a dry conſiſtency, and lets it fall in the different forms of ſnow, hail, *&c.* Froſt is to ſnow or hail, as dew is to rain.

§ 22. Theſe are the various meteoric waters known. To theſe, the fertility of the earth is owing; as they furniſh it, not only with that humidity, which is neceſſary for all its products, but with ſalts and other ſubſtances, that promote vegetation. From theſe, our fountanes and rivers derive their origine: for, after they have furniſhed the ſurface of the earth with what they

they contain or convey, they ſink into its bowels, form for themſelves various canals and aqueducts under ground; until, in ſome depending part, they break through their bounds and burſt forth in the form of a ſpring, with force proportioned to the heighth from whence it falls, and greater or ſmaller in proportion to the fund that ſupplies its courſe.

§ 23. However, we are not to ſuppoſe, that every ſpring gives back its water pure, as it received it from the clouds: for, as in the air, it was liable to be diverſly impregnated; ſo is it alſo in the earth; where it ſuffers various changes, according as thoſe parts, through which it paſſes, contain more or leſs of matters ſoluble in water. Were it not for this, every ſpring would yield up its water unaltered from what it received it from the heavens: of which very few inſtances are known.

§ 24. Snow water, by the antients, was deemed unwholeſom. And many of the moderns aſcribe the bronchocele or preternatural ſwelling of the thyroide and other glands about the throat, a diſtemper obſerved endemial in ſome parts of Switzerland, to the drinking waters, ariſing from the ſnow thawed in the mountains. But, this appears to be abſurd upon examining of ſnow water, which is found as pure, as any other, if not purer. Moreover, this diſtemper is obſervable in many other countries, where ſnow contributes but little to the increaſe of their waters. At Rheims, the capital of Champagne in France, there is hardly an aged perſon free from this diſorder; which is owing to their drinking, till lately, that they have been ſupplied with better, the common water of their wells, which runs through a kind of chalky quarry, with which it is ſtrongly charged. I have obſerved the ſame from the abuſe of Spa water; for a reaſon, which ſhall be aſſigned in its place. And a further vindication of ſnow water from this offenſive quality may be taken from the famous Pfeffer waters in Switzerland. Theſe ſprings flow periodically. They begin

begin in May, and ceaſe, ſo as to be quite dry in September; and this regularly, ſomewhat ſooner or later, every year. Theſe waters, at the ſprings, are warm. And are the lighteſt, pureſt, ſimpleſt water to us known on earth. Yet, they muſt certainly owe their origine to ſnows, which begin to thaw in May, and continue to run till the beginning of September, when the returning cold congeles them and ſtops their current, till the next enſuing ſpring.

§ 25. II. The terreſtrial waters are thoſe, that are found in the bowels or upon the ſurface of the earth. Theſe are always to be preſumed more groſs, heavy and impure, than the meteoric. They are divided into two ſpecial claſſes: 1. Simple or ſweet, rather inſipid waters: 2. More compound and ſapid, mineral or medicated waters. Of thoſe here, of theſe in the ſecond part.

§ 26. The firſt are diſtinguiſhed into, 1. Springs; 2. Wells; 3. Rivers; 4. Lakes; 5. Stagnant waters.

§ 27. 1. Spring or fountane water. This takes its riſe from meteoric water, condenſed or collected on the neighbouring high grounds, and by its frame and gravity entering into the earth, and forming to itſelf fit canals to convey it to ſome place, where it may lie upon a level and at reſt. That ſprings conſiſt of waters, which were ſometime on the ſurface of the earth, is evident from divers conſideration; particularly their frequently carrying with them bodies onely produced on the ſurface of the earth. As at Bath, hazel nutſhells and entire nuts are thrown up by the waters. Beſides, the ſenſible increaſe and decreaſe of ſome, eſpecially the more ſuperficial ſprings, after wet and dry weather, planely ſhews whence they muſt have derived their ſources. Add to this, that in Ægypt, in the Deſerts of Æthiopia and Arabia, in Fierro, one of the Canary Iſlands, and other countries, where neither ſnow, hail or rain are ſeen, they have no fountanes, nor rivers, that ſpring up in them; whileſt Germany,

France,

France, Britain, Ireland, and other nations ſubject to ſnows and rain, abound in living ſprings, rivers and lakes.

§ 28. Next to rain water, that of ſprings is reckoned the moſt pure. However, it is liable to infinite variation, according to the nature of the ſoils, through which it runs: it is more or leſs ſimple according to the ſolubility or inſolubility of the matters, it meets in its paſſage through the bowels of the earth, and according to its proximity to, or remoteneſs from, its ſource.

§ 29. That ſpring is beſt, which runs from a ſteep, rocky, ſtoney or gravelly ſoil, with a quick, ſmart current. Whoſe water is moſt pellucid, and moſt void of all ſenſible ſmell and taſte; moſt readily heated, and moſt ſuddenly cooled, and leaves the leaſt ſediment after boiling, evaporation, or upon ſtanding.

§ 30. The antients, after HIPPOCRATES *, had reſpect to the aſpect of the ſpring, as whether it lay expoſed or run toward the eaſt or weſt, ſouth or north. They preferred the firſt, as ſuffering the leaſt changes from the ſun. Next to that, they eſteemed the ſecond for the like cauſe. They rejected the third, as being liable to be heated and to have the moſt ſubtil parts diſſipated or exhaled by the ſun. And the fourth, they condemned, as crude from its coldneſs, and hard of digeſtion. Theſe reaſons may have their force in the countries in which the fathers of phyſic lived and wrote; but, in our temperate climate, which never feels the extremes of heat or cold, they can be but of very little weight. We are chiefly to conſider the nature of the ſoil around the ſpring, from whoſe ſurface, by collecting the falling rains and ſnows, its origine may be deduced, and the ſoil through which it runs, and the quickneſs or ſlowneſs of its progreſs.

§ 31. In order to make a moſt judicious choice of waters, we ſhould diſtinguiſh ſprings, not only from

* De Aere Locis & Aquis.

their

their ſituation and ſoil, but according to their courſes, whether temporary or conſtant, annual or perrennial; ſtagnant or ſlow-running, quick or flowing ſprings.

§ 32. The temporary ſprings are either uncertain, depending upon the falls of rain or ſnow in all ſeaſons of the year; or periodical or annual, which, from the ſame cauſes, begin to flow in September or October, and continue till April or May. Theſe may be called ſuperficial ſprings. They have no reſervoir or conſiderable receptacle in the bowels of the earth, from which their waters may flow onely in certain determinate quantities; they deliver them, as faſt as they receive them from the clouds or condenſing hills, and for the moſt part, as unchanged. Of theſe, there are great numbers obſervable in almoſt all countries. The moſt conſiderable, that I have ſeen, eſpecially of the latter kind, are in the counties of Clare and Galway, in the kingdom of Ireland; where large tracts of ſome hundreds of acres, of the beſt and ſweeteſt paſturage, are every winter over-whelmed with an inundation, that ſprings up in different parts of the ſoil, clear, pellucid, and almoſt as ſimple, as it fell from the heavens. Theſe can be none other waters, than the meteoric: they fall in the rockey mountains, to whoſe hollow entrails they find eaſy acceſs, and from which they have as free an egreſs; for, being chiefly compoſed of ſtone, without any interpoſition of earth or ſand, and lying ſhelving, the waters cannot tarry long in their paſſage, but muſt precipitately run towards the plane, level grounds, that lie ready to receive them. And, as the ſtones, they waſh, are ſolid lime-ſtone or marble, which, without calcination, are not to be affected by ſimple water; it is not to be wondered, that the waters of theſe temporary or annual ſprings in theſe and ſuch like ſoils, ſhould be of all others the moſt pure. But, were theſe waters, in their falling through the air or their paſſage through the earth, charged with any acid, the caſe would then be different; for as theſe ſtones are ſoluble in acids, hard or petrifying

waters

waters would have been produced. However, when theſe like ſprings ceaſe to flow, they ſoon change their nature, as all ſtagnant waters muſt. The ſlower all ſprings flow, the more charged they may be preſumed to be, and the nearer they approach to the qualities of ſtagnant water. Therefore, the quick, flowing ſpring is to be prefered.

§ 33. The conſtant or perennial ſpring, is that whoſe waters have, from the ſurface, ſunk deep into the bowels of the earth; there, formed to themſelves reſervoirs or repoſitories, where they lie unaffected by the air, and from whence, by paſſages of certain dimenſions, they are delivered conſtantly in the ſame proportionate and uniform current, and of a like temperament in hot and cold, wet and dry ſeaſons. The general notion, that ſprings are colder in ſummer and warmer in winter, is but a vulgar error: they appear ſo to the touch, it is true; becauſe the human, and every other animal, body is hotter in ſummer, than in winter. Such things, as we pronounce cold upon the touch, when we are heated, we ſhould pronounce warm or leſs cold, when we are cooled: and this is the cauſe of this long prevaling miſtake.

§ 34 The ſprings, in a more ſtrict ſenſe, called periodical, are ſuch as flow for a certain determinate number of days, hours, or minutes, and ceaſe for a known time. Of this kind, divers are mentioned by travellers. As one in Judaea, that flows for ſix days, and reſts or ceaſes on the ſeventh; whence, it is called Sabbatticus, the Sabbath, or Sunday ſpring. Some in Sweden and Switzerland, that flow once or twice in the day, and ſome that flow and ceaſe ſeveral times, ſix or eight times, for inſtance, in an hour. I have heared of ſome of this kind in Britain and Ireland; particularly one at Giggleſwick, in Yorkſhire; another, called Lay-well, near Torbay in Devonſhire; but never ſaw any. Various extraordinary conjectures have been made to account for the production of this ſort of ſpring. But, I am of opinion, that whoever

has ſeen a chemiſt's firſt ſeparating funnel, uſed for the parting of eſſential oils from diſtilled waters, a ſiphon or crane for drawing liquors from one veſſel into another, or remembers the draining the Serpentine-river in Hydé-park ſome years ago, by a drain made in a crane-formed canal, with intent to carry off redundant water onely; which, as ſoon as a flood fell, that raiſed the water above the bending of the canal, neceſſarily emptied the river to the level of the ſhorteſt leg of the ſiphon; whoever, I ſay, conſiders theſe natural operations, can not be at a loſs to conceive how ſimilar canals may be formed in the earth; how they ſhould communicate with baſons or ſprings of water, and diſcharge them at different periods, proportioned to the fund of water and the diameter of the tube or aperture. And this, I apprehend, will give a more rational ſolution of the phaenomenon, than having recourſe to a diſtillation by a central or other ſubterranean fire, or to the flux or reflux of the ſea; to which too many have truſted in vane.

§ 35. 2. Well or pump-water approaches neareſt to that of ſprings or fountanes. They all derive their origin from the ſame common ſource. They differ in this, that the later, by nature, ſpring forth and flow on the ſurface of the earth; the former are ſought where ſprings, by the ordinary laws of nature, could not flow ſpontaneous; and are therefore ſunk or dug for, till the ſpring or reſervoir of water be layed open, to be afterwards drawn out by pumps or other convenient machines. Theſe waters differ but accidentally from thoſe of ſprings. They are often more charged and hard, than thoſe of flowing ſprings are generally found. Then, for want of frequent drawing or pumping, they put on the nature of ſtagnant waters. Otherwiſe, they agree with ſprings.

§ 36. 3. Rivers, and 4. Lakes, derive their waters from ſprings; but, vary from them by divers accidents; ſuch as being longer expoſed to the ſun and air; receiving many drains and rivulets from the ſurface

face of the earth, in various places; in the length of their courſes, running over a greater variety of ſoils; receiving ſeveral putrid bodies, vegetable and animal, as well as being the habitation of a great part of the animal creation; all which muſt neceſſarily render theſe waters more compound, than ſprings.

§ 37. Rivers, that take riſe in the higheſt mountanes, and run moſt rapid, like the quickeſt ſprings, are generally the pureſt water. Thus, the Rhine and the Rhoſne, which flow from the Rhetian Alpes, while they preſerve their rapid courſes, are found moſt pure and light. The difference betwixt the Rhine and the Maine, is perceptible to thoſe, that navigate theſe rivers, who find the barges and other loaded veſſels, that ſail from the later into the former, ſink conſiderably deeper in the one, than the other. Thus, rivers differ from each other, as much as ſprings. It is not ſolely the rapidity of the courſe or ſpring of either, that cauſes their waters to be pure and clear. The ſoil through which they paſs, muſt contribute its part; if it be gravelly or ſtoney, the water will be clear; if clayie or loamy, it will be foul and muddy. Thus, we ſee the Seine in France, whoſe courſe is not deemed much leſs precipitate, than that of the Rhine, is foul and turbid, as the Avon below Briſtol, or as any troubled, ſtagnant water; whileſt our Thames, gliding with a much gentler motion over her ſtoney, flinty, gravelly or ſandy bottom, preſerves her purity and pellucidity, until ſhe is tainted with an infinite variety of adventitious bodies from the ſtreets and ſewers of our capital, as well as from the ſcarce numerable ſhips and other veſſels, that reſort her port. River waters being expoſed to the open air, contain every thing, that rain does; and, like that, ferment and putrefy, grow foul, yield alike a fetid vapor, which is inflammable. And as ſoon as this eſcapes, the terrene parts ſubſide, and the water becomes pure and ſweet again.

§ 38. Lakes are, for the moſt part, but expanſions of rivers, and therefore generally partake of their quality and nature. Some are ſeen without any river running into or from them. Theſe are to be conſidered, as a kind of ſtagnant or ſlow-flowing ſprings. It is moſt probable, they have their diſcharges, as well as their ſources, below their ſurfaces, and therefore, inviſible. Some of theſe, as well as the greater, are obſerved, about Switzerland and the Alpes, to have a ſeeming flux and reflux, like the ſea; but, at different periods, and from very different cauſes; the one depending upon the preſence and abſence of the ſun, as the other on the place and changes of the moon. The lakes, as well as ſprings, that owe their riſe to ſnow, increaſe as the ſnow thaws with the heat of the ſun; and from ſun-ſet to ſun-riſe, ebb or ſenſibly decreaſe. This is obſerved in the lake of Geneva, and ſome others.

§ 39. 5. Next to the waters of lakes, the ſtagnant waters of ponds, pools, &c. are to be conſidered. Theſe vary according to the air, ſeaſon, and ſoil in which they ſtand, as well as from the ſource, whence they draw their ſupplies. They are at all times liable to be contaminated with an infinite variety of foregne and foul matters; and in ſummer, with a great variety of ſmall capillary plants, and with living animals numberleſs. Hence, they are always foul, heavy, muddy, and ill-taſted; in the hotter weather, ill-ſmelling and putrid. Conſequently, of all others, the moſt unfit and unwholſom for the uſes of man and beaſt. The bare exhalations of theſe waters infect the air. Whence, all countries, where ſtagnant waters abound, muſt be unhealthful. Such are found the fens of Eſſex, Lincolnſhire, *&c.* the Campania of Rome, and the like.

## *Of the nature and properties of ſimple water.*

§ 40. AS water is moſt indiſpenſably neceſſary for innumerable uſes and purpoſes in the oeconomy of life, it becomes one of the moſt intereſting ſubjects, and the beſt deſeving the attention of all ranks of men, from philoſophers and phyſicians to ruſtics and mechanics.

§ 41. As it is eſſentially neceſſary in the production or ſuſtenance of every part of the creation, reaſon, as well as religion, demands our aſſent to the ſcriptural hiſtory of water, which informs us, that this was the firſt formed element; that part of the terreſtial creation, which was firſt finiſhed by the Almighty's all-creative hand: * A proof that it was intended, by infinite power and wiſdom, as a principal ingredient, or a material inſtrument, in his future works. And this, upon examination, water will be found.

§ 42. Many have been at immenſe pains and labor, to acquire ſome knowledge of the eſſential or conſtituent parts of water; but, they have labored to ſo little purpoſe, that the utmoſt, that has hitherto been learned from all their attempts, is ſome notion of its properties and effects; whence, the definition before given has been drawn.

§ 43. Water has been, by many of the antients, looked upon, as the material principle of all natural bodies; whence it, with ſome, acquired the pompous appellation of Omniſeminaria, the univerſal ſeminary of all material beings. Several of the moderns embraced the ſame opinion.† Whileſt ſome ſuſtain, that the Chaos, mentioned in the ſacred and prophane hiſtories of the creation, was a maſs of a certain kind of viſcous or mucous water, which, by the omnipotent will of the

* Gen. chap. i. † Bohn. in diſſertat. chym. phyſ. Le Mort. in chym. med. phyſ.

author of nature, in the ſcriptures ſtiled the Spirit of God moving upon the waters, ſeparated the waters from the waters; that is, parted this rude maſs into three diſtinct ſpecies of this fluid, or reduced it into three different conſiſtencies or forms; the firſt, and moſt ſubtil of which, is air; the ſecond, the leſs ſubtil or middle ſtate, what we commonly call, and know by the name of, water; the third, or more groſs and heavy, earth of various kinds.* This poſition, which at firſt ſight appears ſomewhat extravagant, will appear more familiar when we come to examine the nature of water more ſtrictly, where the near relation, the intimate and inſeparable connection of theſe three elements, will be made moſt evident; it being hard to find air without water; as it is well known, that water is convertible into, or miſcible with, air; and that there is no water found free from air and earth.

§ 44. Others, inſtead of conſidering earth, as a kind of water, have looked upon water, as a ſort of terrene body, a liquid or fluid earth. After various diſquiſitions upon this head, it became a queſtion, how, and in what, water differed eſſentially from earth? As it alſo did, whether water was not convertible into earth, and earth into water?

§ 45. Theſe, the peripatetics peremptorily oppoſed; holding water and earth to be diſtinct eſſences, two of their four principles or elements of natural bodies, fire, air, water, and earth. With theſe, the patron of itinerant empyrics and ſecret-mongers, Paracelſus, implicitly joined. His obſcure aſſertions can add but little weight to the notions of his party, when he offers neither reaſon nor experiment to ſupport the aſſertion. Whilſt Van Helmont and Becher oppoſe them, and offer ſpecious arguments drawn from experiments and obſervations to ſupport the affirmative; to wit, that water is none other than liquid earth.

* D. Helbig. in introitu in phyſ. veram & inaudit.

§ 46. The

§ 46. The proofs, they offer of this notion, are drawn from the following conſiderations;

§ 47. 1. In order to ſet theſe arguments in the moſt diſtinct light, we muſt here firſt obſerve, that certain philoſophers have placed the eſſence of water in a moſt minute globular form of its parts; others, in a very fine, ſmooth, ſerpentine conformation of its particles; whence, they are pleaſed to ſuppoſe its humidity, fluidity, volatility, or aptneſs to evaporate and mix with the air, are derived.

§ 48. But, a cloſer and clearer method of enquiry and reaſoning has taught us, that, however the form of the particles of water may approach to the globular or ſerpentine, its humidity, fluidity, volatility, &c. will be found to depend upon other, and theſe moſt different, cauſes; to wit, extreme tenuity of parts, and external, adventitious heat; not upon theſe imaginary configurations of parts alone. The different heat or cold of water is owing to outward accidents. In certain degrees of heat, to wit, in thirty three of Fahrenheit's thermometer, and upwards, water is always fluid. Whereas, in thirty two degrees of the ſame machine, and under, it is quite the reverſe, ſolid. It is then owing to this degree of heat, which is outward, adventitious or accidental, that water preſerves the principal properties in our definition; ſince, by a depriva-tion of this heat ſolely, that is, by cold alone, all theſe properties are abſolutely deſtroyed, and the humid, fluid, volatile ſubſtance becomes an hard, ſolid, dry, and in appearance, terrene body. And, on the contrary, by reſtoring the loſſed degree of heat, humidity, fluidity, and other properties are reſtored to the water.

§ 49. Hence, it is plane, we have no competent evidence of the determinate form of the eſſential particles of which water is compoſed, more than of thoſe, of which divers other bodies are formed. We may ſhew the common chemical principles of ſome bodies, in their effects upon certain mixed and compound bodies; but, we muſt have more acute ſenſes, than are

allowed to mere mortals, to behold the ſpecific or eſſential form of the phyſical elements of matter. Wherefore, it is not ſurpriſing, that we have not hitherto been able to aſcertain the proportion, theſe particles bear to others, or the mutual correſpondence in conformation or configuration of parts, that makes ſaline, mucilaginous, gelatinous or gummy, and ſuch like ſubjects intimately mix, and cloſely cohere with this fluid; in other words, that renders this the fit ſolvent for theſe like bodies.

§ 50. This quality of water, its fluidity and ſolidity depending alike on external accidents, is one of the arguments to ſuſtain the opinion of Van Helmont and Becher: For, they judge it probable, that if by any means the particles heavier than water, which cauſed its ſolidity or congelation, could be confined in the water, it muſt retain the ſolid and terrene form, it by theſe means puts on.

§ 51. 2. Theſe notions ſeem favored by ſome experiments cited from Glauber and others. By which it appears, that water, by the addition of a certain quantity of divers dry bodies, may be reduced to a conſiſtent, ſolid form.

§ 52. Thus, we ſee various, earths, which, void of humidity, are but looſe, light, and incoherent duſt; by the addition of water, become conſiſtent and tenacious; and being baked in a proper heat, are rendered ſolid and hard as ſtone. Such are bricks, tiles, and all ſorts of earthen ware.

§ 53. Thus alſo, lime and ſand, with a certain portion of water, puts on a ſtony hardneſs. As does gypſum or plaſter of Paris calcined.

§ 54. The ſame may be ſayed likewiſe of Glauber's ſalt, in ſome ſenſe. This, like other cryſtalliſed ſalts, owes its pellucid and cryſtalline form, as well as much of its weight, to water. This water being exhaled, by expoſing this ſalt to a warmer air, it loſes its pellucidity and becomes a white powder. Upon adding to this a certain quantity of water, it puts on an icy ſolidity.

§ 55. 3. To theſe, they add the intimate union, or cloſe connexion of water with various ſolids. As for example; the neuter ſalt, compoſed of a fixed alcaline ſalt and the vitriolic acid, from its being made with ſalt of tartar and oil of vitriol, called tartar vitriolate; this ſalt, when dried, is able to withſtand the force of an ordinary fuſing heat, without fluxing or flying off. Yet, diſſolved in water, and evaporated in an heat equal to that of boiling water, will loſe conſiderably of its weight. Moſt other like ſalts are obſerved to ſuffer great waſte by this treatment. Whence, the moſt judicious chemiſts uſe the floweſt heat in their evaporations, whether for cryſtalliſation or reducing their ſalts to dryneſs.

§ 56. 4. Not very different from this, is the loſs which lime-water is ſayed, by theſe and other authors, to ſuſtain in evaporation.* By calcination of the lime-ſtone, of marbles, and the ſhells of fiſhes, their nature is ſo far altered, that a conſiderable portion of them becomes ſoluble in common water. Lime-water is prepared by infuſing unſlaked lime or roche-lime in water. A ſalt-like pellicle conſtantly covers the ſurface of this water, and by its gravity, precipitations with various ſalts and metalic ſolutions, by its diſſolving ſulphur, &c. it gives manifeſt proof of its being ſtrongly impregnated with the lime-ſtone, by calcination reduced to an acrid, alcaline, pure earth. Yet, theſe ſtoney, or rather now terrene, particles, capable before of reſiſting the utmoſt torture of fire, thus diſſolved in water, adhere ſo cloſely to it, according to theſe writers, as to fly off entirely with it in evaporation. But, more accurate experiments ſhew this to be very fallacious: Though lime be thus ſoluble; yet, water may not be charged with it, more than with ſalts, above a certain proportion. The portion then, it takes, is at beſt but ſmall; and therefore, there can be but little left after evaporation. But, there appears no

* HOFFMAN obſerv. phyſ. chem. lib. ii. obſ. 10.

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room to doubt of whatever the water contains, remaning after evaporation.

§ 57. 5. Theſe notions, however, ſeem to receive further confirmation from the experiments of BORRICHIUS the learned Dane, Van HELMONT the younger, and our BOYLE, with ſeveral others, who affirm, that earth may and has been ſeparated from water, after one, yea, two hundred diſtillations. This fine, ſand-like earth, which remanes after diſtillation, Van HELMONT will have to be the firſt principle of water. But, this deſerves further and nicer diſquiſition. Let us now come to the proof of our definition, in which this matter will again fall under conſideration; onely tranſiently obſerving, that ſince water is found to have ſuch affinity to earth, and ſince we can trace it in no part of the creation, where it comes not into contact with great variety of terrene, ſaline, and ſalino-ſulphureous bodies, it is not to be wondered, that we never ſee in nature, nor can procure by art, water perfectly pure.

§ 58. The firſt diſtinguiſhing characteriſtics of water, are humidity and fluidity, or humido-fluidity. By humidity is meaned that property of water, by which it adheres, upon contact, to certain bodies, and humects, moiſtens or wets them. Thus, it moiſtens or wets all ſtones, earths, glaſs, metals, woods, *&c.* This property is owing to the extreme tenuity of its parts, which renders them capable of being moſt eaſily ſeparated and divided, and of adhering to ſuch bodies, as come into contact with them, with which they have any attraction; ſuch are thoſe above mentioned. By ſundry other bodies, water is repelled; ſuch are all fat, oily, and reſinous bodies. By its general humecting quality, water is diſtinguiſhed from aqua philoſophorum, the philoſopher's water; aqua ſicca, dry water; and humor radicalis metallorum, the radical moiſture of metals; which mercury or quickſilver is deemed by the chemiſts: For, this attracts, humects, or adheres to no bodies, but certain metals, to which it is ſuppoſed

poſed to miniſter the office, and bear that affinity, which water does to vegetables and animals.

§ 59. Inſeparable from this quality, is that of fluidity; whence, they may properly be united under the term, humido-fluidity. Fluidity is a property, which water holds in common with all other liquors, as it is likewiſe diſtinguiſhed from mercury, by that of humidity. The fluidity of water depends upon two cauſes, the firſt is the extreme ſubtility, or tenuity, of its elementary or component particles; the ſecond, a certain degree of heat, actual fire; without which water, agreeable to our definition, to wit, in a liquid ſtate, is never found.

§. 60. It is impoſſible for finite capacities to meaſure, or even to comprehend, the ſize or form of an elementary particle of water, more than thoſe of other bodies. By experiments and obſervations, we find theſe particles are inconceivably minute, and of a form the fitteſt to paſs through the fineſt tubes or pores imaginable. All animals, as well as vegetables, receive their nutrition and accretion by pores inconceivably ſmall. We daily obſerve ſeveral plants, ſet in water, receiving nouriſhment a while without roots, afterwards ſtriking roots in the water, growing and flouriſhing therein. We ſee variety of other plants live and grow, without receiving any apparent humidity at the roots. This may be obſerved, not only in ſundry ſmall plants, but in ivy, and ſeveral ſhrubs and trees flouriſhing, on arid rocks, old walls, *&c.* But, in many of the ſucculent tribe of aloes and ficoides, this is ſtill more evident; for, ſome of theſe increaſe in bulk and weight, without any root at all. This certainly could not be, unleſs water had free acceſs by the inviſible pores of theſe vegetables, which the particles of elaſtic air are incapable of entering. To this, the conformation of the parts muſt certainly contribute: a ſpherical or globular particle might paſs, where a cube or any other figure, though of equal dimenſions, would be denied admiſſion. But, no figure could poſſibly render

render any particle capable of paſſing through a tube, or pore, of ſmaller dimenſions. Therefore, ſuch particles, as may paſs through perforations, ſo extremely minute, as to eſcape our ſenſes, ſuch as the inſorbent pores of vegetables and animals, muſt neceſſarily be exceſſively ſmall. And ſuch therefore, are the particles of water.

§ 61. From this extreme tenuity of parts, it is eaſy to conceive how water becomes fluid: it is kept in this ſtate, by whatſoever divides or breaks the coheſion of theſe fine parts, and keeps them in motion. This is done by fire. There is no water, in a fluid ſtate, without fire. The degree of fire neceſſary to keep water fluid, is aſcertained by the thermometer. Water kept any where, or at any time, where the mercury falls below thirty three degrees of Fahrenheit's thermometer, will, in a certain ſpace of time, loſe its fluidity, and become a perfect ſolid; to wit, ice. Wherever the mercury riſes in this machine to thirty three degrees or upwards, there the water will be found in the utmoſt fluidity of which it is capable, as far as can be meaſured by human ſenſes or experiments; for, though higher degrees of heat rarefy and expand water, that is, make the ſame quantity of water occupy a greater ſpace, and therefore appear relatively lighter, in proportion as it is heated from the thirty third degree to the two hundred and twelveth or thirteenth, in which it boils; yet, have we not hitherto diſcovered any means of meaſuring the different degrees of fluidity. The pendulum was the method by which Sir ISAAC NEWTON compared the fluidity of hot water to that of cold, and he found the vibrations in both alike. But, this experiment is inſufficient; as no pendulum has been yet diſcovered, that does not expand with heat, as it contracts with cold. And thus, for want of fit machines, this queſtion muſt yet remane undetermined to our ſatisfaction. The beſt proof, that can at preſent be offered, to ſhew, that the fluidity of water cold and hot is nearly the ſame, may be taken from this conſideration; to wit, that whatſoever veſſel is capa-

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ble of containing cold water, is alſo capable of holding hot. This is apparent in pots and kettles, in diſtilling veſſels, in Papin's digeſter, and in the aeolipile: for, as the water does not paſs through theſe or ſuch like veſſels when cold, no more is it capable of paſſing when heated; which, if it were then more fluid, it muſt.

§ 62. To this extreme tenuity of the parts of water, the eaſy rendering it fluid, as well as of diſſipating it in inviſible vapors in the air, are owing. The more minute the particles, the eaſier they are put in motion, the eaſier of courſe they are kept fluid, the eaſier they recede from each other. Thus water, by the ſame degree of heat, that is ſufficient to preſerve the character of fluidity, is divided, diſſipated, or exhaled: for, while it is fluid, it muſt be in motion, and in its motion, ſome parts muſt evaporate or exhale. Thus, we ſee cloaths dry, rivers, lakes, and ponds evidently diminiſh, in very cold weather, as well as in hot, without emitting any viſible vapor. This ſhews the extreme mobility and diviſibility of water; which, the purer it is, the leſs its coheſion, the eaſier it is ſet in motion and diſſipated. This is proved further in the diſtillation of water: The ſimpleſt is moſt eaſily and readily heated, conſequently diſtils the ſooneſt. And, in diſtillation, the parts of water do not cohere like thoſe of oily, ſpirituous, or ſaline liquors, which being raiſed in a warm vapor by heat, and ſtriking againſt the internal ſurface of the glaſs alembic or retort, are condenſed by the external cold of the air, and diſtinguiſh themſelves by running along the glaſs in little vene-like ſtreams or rivulets, and ſo diſtil into the recipient; whileſt water, in the natural ſtate, pure and unaltered by fermentation or putrefaction, being by fire converted into a warm vapor, upon ſtriking againſt the internal ſurface of the diſtilling veſſels, is condenſed in form of a dewy moiſture, and as the drops increaſe in ſize and weight, trickle, or diſtil, in that form, into the receiver. Hence, as freſh water is more eaſily ſet in motion than ſalt, there muſt

be a greater exhalation, in proportion, from ſprings, rivers, lakes, and other freſh waters, than from the ſea. This is exactly calculated by that very learned and ingenious philoſopher, the reverend Dr. HALES.*

§ 63. The next characteriſtics of water, ſet forth in our definition, its being pellucid, colorleſs, inodorous and inſipid, are ſo apparent to the ſenſes, that they need no further diſquiſition to prove them. Various bodies are found in divers waters, which diminiſh or obſtruct their pellucidity, give them a color, ſmell, and taſte; but, ſuch make none eſſential part of the water, and are to be looked upon as foregne and adventitious. The nearer any water comes to this part of our definition, the purer it is; as on the other hand, the further it recedes from this character, the more foul and impure or compound will it ever be found.

§ 64. Water is lighter than earths, properly ſo called: theſe are not ſoluble in ſimple water. And though reduced to the utmoſt tenuity by trituration or grinding, they are incapable of being long ſuſpended in water; but, muſt by their ſuperior gravity preponderate and ſubſide; unleſs they be firſt diſſolved in ſome proper ſolvent; in which caſe, the parts of theſe ſolids being by diſſolution ſo minutely divided, as to be reduced to a fluid ſtate, are then made capable of mixing with and being ſuſpended in water.

§ 65. Water, in which any terrene ſubſtance is onely mixed, appears muddy and foul, but will fine, by the ſubſidence of the ſolid parts, upon ſtanding. Such a water may then be ſoft and pure. But, water, in which the terrene parts are by any means diſſolved, muſt be always hard, and heavier, than pure water, in proportion, as it is charged with ſuch foregne matter. Hence, the cleaneſt and lighteſt water is the pureſt, ſimpleſt, and beſt, for ordinary purpoſes.

§ 66. As earth is heavier than water, ſo is water heavier than air. Water reſolved into vapor, is ſo light, as to be then capable of floating a while in the

* See Philoſ. Tranſ. No. 189, p. 366.

air;

air; but, as ſoon, as it is by any means condenſed, it preponderates in its original form: thus, dew and rain are produced, and thus is diſtillation performed; or, if the medium through which the aqueous vapor or exhalation paſſes in its condenſation be cold enough, to wit, of thirty two degrees of Fahrenheit's thermometer or under, it will then deſcend in a ſolid form; that of ſnow, hail, or froſt.

§ 67. Water is not onely heavier, than that ſubtil, natural fluid, air; but, it is alſo found heavier, than divers artificial liquors; ſuch as moſt oils; not onely thoſe obtained by diſtillation from aromatic vegetables, which are very light and ſubtil for the moſt part; but thoſe obtained by boiling or expreſſing divers parts of vegetables, as well as animals; though ſuch be groſs, mucilaginous, and viſcid. Hence, all theſe like bodies never unite with water; but, being mixed therewith by agitation, ſoon ſeparate from it, by a certain diſſimilarity in the make and conſtituent parts of each; whence ſimilar, or like attract like; whileſt diſſimilar or unlike repel each other: for, the particles of oil ſeparated by the interpoſition of the water, ſoon after, attract each other; repelling or rejecting the water, whoſe parts, at the ſame time, attract each other and repel thoſe of the oil, unite in globules, ariſe and float upon the water. However, to the later part of this general rule, there is an exception: for, not onely the groſs empyreumatic or aduſt oils of guajacum, box, *&c.* but the eſſential oils of cinnamon, cloves, ſaſſafras, *&c.* are found heavier than water. None oily or ſulphureous bodies, as is hence evident, are ſoluble in pure water; no more are the fat of animals, the balſams or reſins of vegetables, nor the various bitumens or foſſil oils, balſams, or reſins, that are found in various countries in the bowels of the earth. With theſe, common brimſtone may be enumerated: for, none of theſe are ever found diſſolved in water, by nature or art; without the interpoſition of ſome proper ſalt, capable of diſſolving them, or ſome viſcous

ſubſtance

ſubſtance capable of intangling them, as ſhall be further explaned in treating of the different medicated waters.

§ 68. When water is found heavier, than moſt eſſential oils, it will not be thought ſtrange, that it ſhould be heavier, than burning ſpirits, which are oils attenuated and ſubtiliſed by the action of fermentation, and united with a certain portion of water. This water is inſeparable from burning ſpirits; and this it is, that makes the moſt dephlegmated or rectified ſpirit readily mix with other waters, which the oils are found incapable of doing, for want of ſuch a proportion. However, though rectified ſpirit and water readily mix and intimately unite; yet, if water be, by a funnel, conveyed to the bottom of ſuch ſpirit, or the ſpirit be poured gradually upon the ſurface of water; each will keep its reſpective place, till by motion they are mixed. Then, they can be ſeparated onely by fire, which in diſtillation raiſes the lighteſt body, the ſpirit, firſt; or by the interpoſition of ſuch bodies, as have a greater affinity or ſtronger attraction to the one, than the other; thus, the mixture being charged with fixed alcaline ſalts, as far as it is capable, the ſalts and water attract each other moſt ſtrongly, fall to the bottom, and ſet the ſpirit free. In like manner, the mixture of ſpirit and water, being expoſed to a freeſing cold, thirty-two degrees by the thermometer, the cold will deprive the water of its liquidity, and reduce it to ſolid ice; while it leaves the ſpirit free and fluid.

§ 69. We are now to conſider the incompreſſibility of water. We cannot with certainty demonſtrate the conſiſtency, more than we can the form and ſize, of the conſtituent particles of water. From their immutability, it is preſumed they are extremely hard and conſequently unalterable in their nature: for, water rarefied by fire into a vapor ſubtil and elaſtic as air, may be condenſed into water again, with all the properties and characteriſtics, it poſſeſſed before this change. And water, by cold condenſed into a ſolid, may be reduced again to a fluid ſtate, as is ice, by thawing

thawing with heat, and appears then of the ſame humidity, fluidity, gravity and other qualities, as before this change; which, certainly, could not have been, had the nature or form of the particles been eſſentially altered. From this extreme hardneſs of the parts, we may preſume, the incompreſſibility of water ariſes. This would appear upon every experiment more evident, could water be found free of that elaſtic, compreſſible fluid, air. But, this may not be: for, water, however conſtructed, muſt have pores, and theſe pores, like thoſe of other bodies, muſt be filled with particles of the ſubtil, penetrating, elaſtic fluid, that ſurrounds and preſſes in all directions upon them; and this is air. Water may be, for a while, freed from air, by certain degrees of heat, and by taking off the whole preſſure of the atmoſphere by an air-pump; but, in proportion as the heat is removed, or the preſſure of the atmoſphere is reſtored, the circumambient air, with all its contents, will be imbibed by, and, in ſome proportion, imbodied with, the water. Hence, we hardly ever find water in the natural ſtate, fluid, ſo effectually diveſted of air, as to admit of making the experiments for proving its incompreſſibility, with due propriety and exactneſs. From hence, we may eaſily account for the variety, that appears in the different relations of ſimilar experiments recorded by different authors, of equal credit and reputation, in moſt other reſpects. The celebrated ITALIAN PHILOSOPHERS * have tried to condenſe or compreſs water by various means. As 1. By the preſſure of the elaſtic vapor of water. This was increaſed to a degree not onely ſufficient to burſt glaſs veſſels, but to break through the ſolder of braſs ones; yet, without making any impreſſion upon the ſurface of water in a tube, on which the whole force was impreſſed. 2. The like trial was alſo made with quick-ſilver; with the like ſucceſs: for, a column of water was found not to yield an hair's breadth to the

* Academ. del Cimento, Lat. Edit. by Van MUSSCHENBROEK.

utmoſt weight of mercury, the containing glaſſes could bear, which was eighty pounds. 3. The third trial was by filling a thin ſilver globe with water, cooling it with ice or ſnow, and ſtopping it with a very firm and cloſe ſcrew. The globe thus filled and ſtopped, being on all ſides gently ſtruck with an hammer, was bulged in at every ſtroke; but, the water, inſtead of ſuffering itſelf to be compreſſed, made its way through the pores of the metal, as quickſilver paſſes, upon preſſure, through the pores of leather. What extraordinary reſiſtance! What extreme tenuity of parts!

§ 70. DU HAMEL, an ingenious and acurate philoſopher, further confirms the third experiment; by filling a golden ſphere perfectly with water and afterwards compreſſing it equally; whereupon the water tranſudes by the pores of that moſt ſolid metal, inſtead of yielding to the compreſſure. This, at the ſame time, demonſtrates the extreme ſubtility and penetrability of water, as it proves its incondenſability or incompreſſibility, which undoubtedly ariſes from the extreme hardneſs of its conſtituent particles.

§ 71. Theſe experiments receive new weight and light by the exact and faithful experiments of the famous TRANSLATER and COMMENTATOR of the FLORENTINE ACADEMICIANS, in oppoſition to ſome other philoſophers, whoſe experiments ſeemed to denote, that water was in ſome degree compreſſible. This faith-worthy philoſopher filled two ſpheres of lead and tin, each of three inches diameter, and one tenth of an inch thick, with water freed from air by the air-pump in cold weather, and then placing theſe ſpheres under receivers, and exhauſting them by the pump, aſſured himſelf, they were filled with water onely; then ſtopping the tube, by which they were filled, by driving a leaden pin a finger's breadth into it, and afterwards cloſing it well with ſolder, he placed each in a preſs, where they re-

* M. VAN MUSSCHENBROEK.

quired

quired the force of a conſiderably long leaver before they took any impreſſion. And, as ſoon, as the figure of the ſphere was ſeen to alter, its ſurface was all over covered with a thick dewy tranſudation, which increaſed, as the preſſure was augmented. This, he has frequently demonſtrated in his public courſes in the univerſities of Utrecht and Leyden.

§ 72. Mr. KING, in his courſe of experiments in natural philoſophy, ſhews a copper ſphere, in the orifice of which, a ſtrong, cloſe ſcrew is made, to which a ſcrewpin, with a fit handle is adapted. This ſphere being filled with cold water, the ſcrew, being well greaſed, may be turned with proper force. But, it is no ſooner turned, ſo as to compreſs the water with any force, than the fluid eſcapes, as above, through the pores of the metal.

§ 73. Hence, it is juſt to conclude, with M. V. MUSSCHENBROEK, that Lord VERULAM, M. FABRY, COLBERT, MAGIOTT, BOYLE and others were deceived, when they pronounced water compreſſible from its running out with rapidity by a perforation made in a globe filled with water and compreſſed by ſcrews or otherwiſe; and it is reaſonable to judge, that this current of water was owing to air contained in the water, or ill-filled ſphere, or to the elaſticity of the metal, which had yielded to the force impreſſed upon it in filling it with a ſyringe. The ſtricteſt care is to be taken in the making theſe experiments: For, though the air commonly contained in the pores of water, be not elaſtic there, while the liquor continues cold and fluid; yet, upon ſlight heat, it will recover its elaſticity, the water itſelf will be rarefied, and it will ruſh forth with rapidity by any aperture; or, if the heat be ſufficiently increaſed, it will burſt the ſtrongeſt veſſel with a moſt loud and violent exploſion. All metals are capable of expanſion and contraction by heat and cold, and are alſo all more or leſs elaſtic. Wherefore, he who makes theſe like experiments, without due regard to theſe circumſtances, will eternally deceive and be deceived.

§ 74. Water is an uninflammable fluid. The utmoſt force of fire can not raiſe the heat of water above two hundred and thirteen degrees, in which it boils. We are not yet able to aſſign a ſatisfactory cauſe, why certain bodies admit of certain degrees of heat and no more. Until we are, we ſhall not be able to ſhew, why ſome fluids are, and others are not, inflammable. Here, as in many other inſtances, we muſt be content with knowing little more, than the effects alone. We find then, moſt fewel requires greater heat to kindle it and make it burn, than two hundred and thirteen degrees. But, water is not capable of more; therefore, it can not be inflammable or burn; but, on the contrary, muſt extinguiſh fewel ſet on fire, while it is yet boiling hot; becauſe, even at the utmoſt heighth of its heat, it diminiſhes the degree neceſſary to burn fewel.

§ 75. Though water be uninflammable, it is capable of great rarefaction and extreme expanſion, with moſt remarkable elaſticity. All bodies are rarefied and expanded by fire; as they contract or are condenſed by cold. And no body, that is not ſuſceptible of greater heat, is more ſenſibly affected in this way by fire, than water. Every degree of heat above the thirty ſecond, keeps water fluid, conſequently in motion, which is increaſed, as far as the two hundred and twelveth or thirteenth, and no higher. In all theſe degrees of heat, the water is in itſelf rarefied and expanded, while part of it is diſſipated in inviſible or viſible exhalations or vapors; than which, there is hardly anything more elaſtic. The extreme force of water converted to ſteam or vapor by fire is ſhewn in SAVERY's engine for raiſing water by fire, ſuch as is uſed at York-buildings, in ſome of the Chelſea water works, and in our mines. In theſe, the hot vapor confined in a cylinder, overcoming the preſſure of the atmoſphere, raiſes a piſton adapted to the cylinder and annexed to the end of a leaver balanced on pinions in the middle. This vapor being condenſed, by the admiſſion of cold water into the cylinder, takes off the

reſiſt-

reſiſtance, which the heated vapor gave the weight of the incumbent atmoſphere; and thus an alternate motion is given to one end of a leaver, ſufficient to ſet pumps going by the other, to raiſe an immenſe weight of water to any heighth.

§ 76. If a long necked glaſs phial be filled with boiling water, and then ſet by in a cool place, as it cools, the tube or neck of the phial will appear empty, as if ſome of the water had exhaled. But, upon giving it the ſame degree of heat again, the contained water will be again rarefied and will expand ſo far, as to occupy the ſame ſpace it did before. This effect is produced, not by attenuating or dividing its component particles, but by agitating them againſt one another and expanding them or enlarging their bulks, which cold alone can reduce.

§ 77. If two glaſs phials of equal ſtrength and dimenſions be taken, the one filled with gun-powder, and in the other one drop of cold water be inſtilled; then both equally well ſtopped and ſet on the fire; it will be found, that the former will burſt with a ſlight noiſe, the latter with a loud and violent exploſion, that will throw the fire and glaſs about forcibly *. This ſhews the power of water, rarefied into vapor, to excede that of gun-powder. And, I am apt to think, moſt earth-quakes are produced by the ſudden rarefaction of water by ſubterranean heat, where the vapor has no vent: for, I know no body capable of reſiſting the expanſive force of the ſteam of boiling water confined.

§ 78. Some ignorant perſons, to prevent the boiling over of unctuous and emplaſtic bodies, with pitch, reſin and the like, or to extinguiſh them when ſet on fire, throw water upon them; but, this always increaſes the evil, it is deſigned to remedy or prevent: for, the water is rarefied by the heat, and burſts out with rapidity and exploſion, proportioned to the heat and the reſiſtance, it meets from the tenacity of the pitch or

* M. V. MUSSCHENBROEK.

reſin, and ſo increaſes the boiling and combuſtion. This expanſive force is well known to founders, eſpecially of braſs and iron. Theſe often fatally experience the dreadful effects of caſting their fuſed metals into wet moulds. The ſlight moiſture barely neceſſary to make the ſand, of which their moulds are made, cohere, never fails of cauſing ſome exploſion. But, if they happen to be more moiſt, than ordinary, then the exploſion is ſo extremely violent, as not onely to ſhock dreadfully, with its ſound, but to burſt the moulds and throw the metal about with horrible force, to a conſiderable diſtance. There is nothing more ſurpriſing and to us unaccountable, than that water, which is not onely incompreſſible, but abſolutely inelaſtic, ſhould by fire be rendered ſo ſenſibly and powerfully elaſtic, and again, by certain degrees of cold, be totally ſpoiled of this quality.

§ 79. To this may be added the extraordinary power of rarefied and agitated water confined, in diſſolving the hardeſt parts of vegetables and animals. The hardeſt bone may in a few minutes be diſſolved in Papin's digeſter. So that water thus becomes the moſt penetrating of all known fluids: for, if we except fire and light, magnetic and electrical effluvia, we ſhall find nothing ſo powerful in pervading bodies, as water, in this ſtate eſpecially.

§ 80. As water is partly indebted to fire for its fluidity, and is by heat capable of rarefaction and expanſion, with extroardinary elaſticity; ſo is it ſpoiled of all theſe properties by cold; that is, in thirty three degrees of heat, it is fluid, but neither rarefied nor expanded ſenſibly, nor does it ſhew any ſign of elaſticity. And, in thirty two degrees, it changes its form and nature, and from an inelaſtic fluid, becomes a ſolid elaſtic body; to wit, ice. This ſurpriſing metamorphoſis has induced ſome * to pronounce ice the natural ſtate of water. But, this expreſſion is a little too

* BOERHAAVE's Elem. Chem. Tom. I. p. 614. in marg.

vague;

vague: for, water is deſtined to ſerve innumerable purpoſes in the creation, which ice can not effect. Water is deſigned to be the habitation of as great a number and variety of animals, as are known on the dry ſurface of the earth. They were ſurely made to inhabit a fluid, not a dry and ſolid, element. And to theſe, it can prove the vehicle of nutrition in a fluid, not in a ſolid, ſtate. There are, it is certain, parts of the world, where the cold is ſuch, as keeps water always in a ſolid ſtate, that is, froſen. Here, it is undoubtedly natural; the laws of nature eternal and irrevocable have made it ſo, at the poles of this globe, where thirty three degrees of heat can never be known. But, when and wherever that degree of heat is felt in the atmoſphere, then and there, froſt can not be ſeen, and there, water muſt remane fluid: wherefore, fluidity may, at leſt with equal reaſon, be pronounced the natural ſtate of water *.

§ 82. Ice is looked upon, by the ſame author, as a certain kind of glaſs, which fuſes or liquefies in thirty three degrees of heat, and, in any degree under that, becomes again hard and ſolid. Then, it acquires the principal characteriſtics of glaſs; it becomes an hard, elaſtic, fragile, pellucid, inodorous, inſipid body, which bears cutting and poliſhing like glaſs, and may be formed into Lenſes and burning-glaſſes. In what then does it differ from common glaſs?—In gravity, fuſibility and fixity. It has been before obſerved, that water, in itſelf, inelaſtic, is by fire rendered powerfully elaſtic. Here the ſame effect is produced by the abſence of heat, cold: for, a globe of ice, falling on any hard body, rebounds, as a globe of glaſs does. And the colder, the harder and more elaſtic it is always found. Some have imagined, that in long con-

* How juſtly phyſical, as well as elegantly poetical, has our MILTON painted this, in his matchleſs poem on Paradiſe Loſed.

——— On the watery calm,
His brooding wings, the Spirit of God outſpread,
And vital virtue infuſed and vital warmth,
Throughout the fluid Maſs. ———

tinued and extreme cold, water is actually converted into gems or cryſtal. But, this muſt paſs for a groundleſs conjecture; till better authority be given, than has as yet appeared: for, as far as we can diſcover, the freeſing of water onely offers an other argument to prove the immutability of its nature; becauſe, the hardeſt ice, we have ever ſeen, has thawed in every degree of heat above thirty two, and then was always found to poſſeſs the ſame character and qualities preciſely, that it had done before that transformation.

§ 82. Ice differs from glaſs not onely in fuſibility, but in fixity: for, common glaſs ſtands the utmoſt degree of fire without waſte. Whereas, ice is capable of being volatiliſed by the degree of heat, ſufficient to fuſe or thaw it.

§ 83. Another material inſtance, in which ice is found to differ from glaſs, is that of gravity. All glaſs is heavier than water; ice in general, more light. But, this is accidental: as water cannot be obtained, and expoſed to freeſe conveniently, without air; ſo ice without air is hard to be found. The interſtices of water are always found full of air. And, though this air, by the diſunion of its parts by the mixture of any other fluid, loſes its elaſtic property; yet, as the particles of water are brought into cloſer contact and union by the freeſing cold; ſo the particles of air, before diſunited, now come together and form air bubbles with all their natural properties. Theſe it is, which expanding give that levity to ice, as to make it float upon the very water, of which it was formed. And, it is this expanded air, that burſts the ſtrongeſt known veſſels, filled with water, ſtopped and froſen *.

§ 84. If water were to be thoroughly freed from air, by expoſing it to cold, more ponderous ice may be obtained. Thus, water froſen after boiling, or in vacuo, gives ice, more ſolid and ponderous, more equal and pellucid, than ordinary. The FLORENTINE PHILOSOPHERS † have thus made ice, that would not

* See the Exp. of the Acad. del Cimento.
† Acad. del Cimento.

float

float upon water. Whence, we may conclude, its levity is ſolely owing to the air, contained in the water. Whoever then is deſirous to ſee ice of this kind, let him take the pureſt water, the freeſt from air, as well as terreſtreity, and freeſe it in the greateſt cold of nature, aided by art, according to the Florentine or Fahrenheit's method, and he will have the pureſt and hardeſt ice. But, with all his care, it will be ſtill found fuſible in thirty three degrees of heat. Whence, we may conclude, that the notion of water's being converted into gems or cryſtal by the natural cold is ridiculous; ſince that, augmented about forty degrees by art, proves utterly ineffectual to this purpoſe.

§ 85. The component parts of common water are very heterogene. There are few bodies in nature, into whoſe compoſition water does not enter, or to whom it does not, in ſome manner or form, adhere. And there are very few bodies, that are not capable of being, by one means or other, ſuſpended in water. Hence, we find the pureſt water in nature always charged, in ſome proportion, with all the other elements, as fire, air, and earth of various kinds.

§ 86. We have already ſhewn, that water in a fluid ſtate can not exiſt without thirty three degrees of fire; under this, it is converted into an hard ſolid body, ice.

§ 87. At the ſame time, it has appeared, that air is always imbibed, in ſome proportion, by water. There is no water, that does not diſcharge much air, upon being heated, as well as froſen, and upon being put under the exhauſted receiver of an air-pump. And as ſoon, as the cauſe, that expelled this air is removed, new air ruſhes in and fills the interſtices of the water, as before. Some water has more of this air, than others; the light mineral or chalybeate waters of Pyrmont and Spa, moſt of any.

§ 88. The exiſtence of earth in waters is manifeſted upon evaporation or diſtillation to a dryneſs. Some are ſo charged with earthy or ſtoney matter, as to grow milkey upon boiling, or to coat the veſſel in

which they are boiled, with ſuch a ſubſtance. But, the lighteſt and pureſt known in nature is not free from this mixture, nor can it be totally diveſted of it by art. For, in evaporation to a dryneſs, in the moſt careful manner, a conſiderable quantity of ſolid earthy matter remanes. And, in diſtillation, in the cloſeſt veſſels, the like ſediment is left, and that after many repeted diſtillations.

§ 89. Mr. BOYLE informs us *, not altogether upon his own knowledge indeed, that rain water diſtilled near two hundred times, in clean glaſſes, always left a white, inſipid, terrene ſediment in the bottom.

§ 90. This may be true, if water could be diſtilled ſo often without entirely evaporating at the beſt cloſed junctures, which may be reaſonably doubted. But, taking the poſition for granted, all the earth remaning after this proceſs is not to be entirely attributed to the water: for, as water can not be diſtilled, much leſs evaporated without air, and as there is none air free from duſt or other ſubtil terrene matter ſuſpended in it; it is not to be wondered, that water paſſing through new air, at the ſame time, that it parts with ſome of its terreſtreity in diſtillation, ſhould collect more from the air in the empty part of the diſtilling veſſels, through which it neceſſarily paſſes. So that, as rain is looked upon as the ley or waſh of the atmoſphere; ſo water, with all the ordinary cautions diſtilled, may juſtly be conſidered onely as the ley or waſh of ſuch a portion of that air or atmoſphere, as neceſſarily occupies thoſe parts of the diſtilling veſſels, which are not filled with the liquor to be diſtilled.

§ 91. Thus, though diſtilling be the moſt effectual method, we know, of purifying water, we are not to expect it more pure after repeted diſtillations in the ordinary manner, than after one; nor are we to ſuſpect, that all the earth, which is ſeparated from it in repeted diſtillations, preexiſted in the water.

§ 92. To diſtil water, ſo as to render it as pure, as poſſible, I recommend the following Apparatus and method;

* Of forms and qualities.

§ 93.

§ 93. 1. A glaſs cucurbit of a convenient ſize, with a moor's head and beak, all of a piece, and a perforation at the crown of the head, to which a glaſs ſtopple ſhould be ground and adapted.

§ 94. 2. A long necked matrace, tubulated at the boll, to ſerve as a recipient.

§ 95. 3. A ſtrong glaſs bottle, large enough to contain the quantity of water to be diſtilled, with a long neck and a mouth adapted to the tube of the recipient.

§ 96. 4. A convenient ſand-bath furnace, in which the cucurbit may be placed for diſtillation.

§ 97. The method of proceding, I recommend, is this; let three fourths of the cucurbit be charged with the cleaneſt and neweſt collected rain, or rather ſnow water. Let it be placed in the ſand-bath, within three fingers breadth of the pot, and let it be covered with water, about half as high, as the water to be diſtilled. Then, let the tubulated matrace be joined by way of recipient to the beak of the moor's head. Let its boll be ſupported by a convenient round, with its tube inverted into the bottle, which is to receive the diſtilling water. Having luted the junctures with a thin paſte made of fine almond or linſeed meal one part, wheaten flower two parts and the glare of eggs a ſufficient quantity, let the fire be gradually adminiſtered and regulated, with the neceſſary cautions, till the water is all diſtilled.

§ 98. Thus water, pure enough for moſt experiments, may be obtained. But, as it is to be preſumed, that while it loſſed the quantity of earth, which is found in the bottom of the cucurbit, it gained more from the air in the veſſels, through which it paſſed in the diſtillation, if the veſſel No. 3. be removed, before all is cold, and the water poured back into the cucurbit, by the opening in the head, letting it touch none of the external air, it may now be diſtilled through a purer medium, than before, partly through that very air, which it had in the former diſtillation waſhed, with ſome new to fill up the ſpace of that, which was expelled

in

in the rarefaction by the diſtilling heat. And thus, by a ſecond or third diſtillation, without removing the veſſels or opening them ſo, as any conſiderable quantity of the impurities of the external air ſhould enter, water may be diſtilled to the utmoſt purity, of which we as yet know it capable.

§ 99. This diſtilled water may ſerve as a ſtandard, by which all others may be tried, by compariſon. It will be found the lighteſt upon the balance; although rain or ſnow may, at ſome times and in certain places, be collected ſo, as nearly to equal it in this reſpect.

§ 100. The purity of water is determined by the following, among other analogous, experiments.

§ 101. Soap diſſolves in ſpirit of wine. This ſolution dropped into pure water mixes ſmoothly and equally with it. But, in impure or hard water, it coagulates or curdles, the ſoap being firſt ſeparated in clouds, and afterwards decompoſed; that is, the ſalt and oil or fat, that compoſed it, parted.

§ 102. The pureſt water is eaſieſt heated and ſooneſt cooled. Common waters are heated or cooled ſooner or later in proportion to the quantity of ſolid parts ſuſpended in them. The harder or more charged any water is, the more difficultly it is heated and the more ſlowly it is cooled. Conſequently the more unfit for diſtillation, and the leſs apt to freeſe. Petrifying waters are rarely froſen.

§ 103. The metalic ſolutions, particularly thoſe of gold in aqua regia, that of ſilver and of quickſilver in the acid of nitre and that of lead in diſtilled vinegar, all ſuffer themſelves to be diluted with, and remaine ſometime ſuſpended in, this pure water: whereas, in leſs pure waters, thoſe charged with terrene or ſaline parts eſpecially, upon theſe ſolutions being dropped into them, they grow turbid or cloudy, and the metals are ſuddenly precipitated in the form of a magiſtery, for reaſons hereafter to be aſſigned.

§ 104. Though we have not as yet found the means of reducing water to perfect, elementary ſimplicity; yet,

yet, we find it in ordinary the ſimpleſt, as it may be looked upon as the baſis, of all other fluids.

§ 105. Hence, the extraordinary lenity or mildneſs of water; that is, its freedom from all ſharpneſs or acrimony. This quality renders water inoffenſive and perfectly agreeable to the parts of moſt exquiſite ſenſibility in an animal body, when by fire it is brought to the ſame temperature with the juices of the animal. Thus, it cauſes none uneaſy ſenſation in the eye, nor excites any ſmell or gives any kind of irritation to the noſtrils, where the fine branches of the olfactory nerves lye almoſt bare. Likewiſe, in wounds and ulcers, where the membranes or nerves are layed bare, and can ſuffer none other application, without increaſe of pain, warm water mollifies and aſſuages. And in the moſt violent inflammations, where every thing, that touches, whether ſolid or fluid, increaſes the acuteneſs of the pain, warm water, or its vapor, brings preſent eaſe and comfort. As it mixes with, diſſolves and dilutes all ſharp and corroſive ſalts, it muſt have the like good effect taken internally, where ſuch are found to predominate; whence, it has, in theſe like intentions, internal, as well, as external, obtained in practice from the earlieſt ages of phyſic, till, by a ſhameful and unaccountable infatuation, it became ſo far neglected in this conceited age, in which we live, that a BOERHAAVE or an HOFFMAN may not be hoped able to reſtore it to its priſtine uſe and reputation.

§ 106. The great ſimplicity of water has given it alſo the extraordinary quality of being the moſt powerful, the moſt univerſal ſolvent, as yet known in nature or art. Thus, water is found more generally and effectually to inſinuate itſelf, than any other liquor, into the pores and interſtices of a great variety of bodies, to break their connections and divide them into parts ſo fine, as to be capable of mixing with, and being inviſibly ſuſpended, in this fluid; ſo that the body diſſolved ſhall be ſo equally diſtributed between the parts of the ſolvent or water, that in every part thereof,

of, a proportionate quantity of the matter diſſolved is always found.

§ 107. The bodies, which water diſſolves with the greateſt facility are ſalts of all kinds, whether ſolid or fluid, natural or artificial.

§ 108. The ſalts, which water moſt commonly meets in its paſſage through the earth, are the ſolid foſſil ſalts; either ſimple, as ſal gem, or ſea ſalt, ſal ammoniac, borax, nitre of the antients, or theſe compounded together. To which, the various vitriols may be added. The other ſimple foſſil ſalts are never found naturally pure, in a ſolid or dry form; but, from an extraordinary attraction with water, always imbibe enough of it to ſecure to themſelves a liquid form; unleſs when they unite with ſome terrene baſe. The firſt of theſe, and ſeemingly the firſt in the creation, is that univerſal acid, which pervades the whole ſyſtem of nature, and though it be called foſſil, from its being collected in greateſt plenty from certain foſſil bodies; yet, we can trace it in the vegetable and animal creations, though ſomewhat altered from the original; and the whole region of the air is charged with it; as appears from the corroſion of metals and the ſaturation or neutraliſation of alkaline ſalts; that is, the expoſing fixed alcaline ſalts to the open moiſt air; by which, the ſame effect will be produced, in a certain time, as if they were immediately ſaturated with the ſame acid procured by art; to wit, the concrete, called, tartar vitriolate, will be the reſult. This affords a proper caution in the preparing the ley of alcaline ſalts, as that, called, the oil of tartar, in particular, which is directed to be made by expoſing this alcaline ſalt to the open air, till it abſorbs humidity enough to diſſolve it. But, in being thus expoſed, it muſt, with humidity, always imbibe more or leſs acidity, and conſequently be, in ſome meaſure and degree, neutrated. Hence, we can find no common alcaline ſalt without ſome neuter ſalt with it, and that commonly tartar vitriolate. This acid abounds in various parts of the earth, ſo as to produce various concretes, from whence we obtain it by art. Thus, the univerſal acid with iron makes green,

green, with copper, blew vitriol, or copperoſe; with zinc, white vitriol; with the inflammable principle, called, Phlogiſton, ſulphur or common brimſtone; with a certain earth, alum, and ſo forth. From theſe, the green vitriol and ſulphur eſpecially, we extract this acid by fire; whence, it vulgarly bears the name of the concrete, from which it was drawn; though it be but one and the ſame, whence ſoever drawn, when perfectly pure. This acid may be obtained by a particular proceſs in a ſolid, icy form, in which, it is impoſſible to keep it long. But, in all the ordinary operations, it imbibes, with great avidity, enough of the humidity of the air, to keep it conſtantly liquid. And it holds this moiſture ſo faſt, that no degree of fire will afterwards ſeparate them. This is looked upon as the baſis of all the other acids, produced by nature or art; whence, it is by ſome called, primogenial.

§ 109. The other liquid, foſſil acid ſalts are the acid ſpirits of common ſalt and modern nitre. Theſe are always liquid, nor can they be obtained in any other form, from their firm union with water, and their volatility, which is not inferior to that of water.

§ 110. The ſolid and liquid ſalts are all ſoluble in water; but, in a different manner and proportion. The ſolid will all diſſolve in water; but, they each require a certain proportion of the fluid to diſſolve them, and the ſolvent may be ſo ſaturated, that it can take up no more of the ſolid ſalt, but leaves it untouched, as if it were not ſoluble therein. But, when the ſalt is once equally diſſolved in a ſufficient quantity of water; then it is capable of being further diſſolved or diluted with any greater or leſs quantity of water. Thus, the acid ſalts, being always in a fluid form; that is, already diſſolved in a ſufficient quantity of aqueous humidity, may be diſſolved in the ſmalleſt quantity of water imaginable, that is, further diluted therewith.

§ 111. It is by being in continual motion, that water effects the diſſolution of bodies. By this it is, that the ſeveral unſaturated parts of the ſolvent come into contact with, and act upon, the ſolvend. This is proved

proved by the diſſolving power of water being increaſed by heat, which onely augments its motion; and is further evinced by the ſalts ſeparating from the water, when by cold it is brought into a ſtate of reſt or inaction. Thus, for inſtance, if a ſolution of any of theſe ſolid, foſſil ſalts be expoſed to air cold enough to deprive the water of motion, that is, to freeſe it; in proportion, as the cold increaſes, the ſalt will ſeparate from the water; and the water reduced to ice will be found void of ſalt. And thus may ſea ſalt be prepared in cold climates, where fewel may be ſcarce *.

§ 112. Heated water diſſolves more of any ſalt, than cold. But, when thus charged, as ſoon as it cools, the ſuperabundance will ſeparate in its natural form, leaving no more in the water, than it was capable of diſſolving when cold.

§ 113. Water not only diſſolves more of one ſalt than of an other, but when ſaturated with one ſalt, will receive more of another. The foſſil ſalts, that contain moſt water and leſt earth, are the moſt ſoluble: Thus, ſal gem, ſea ſalt or nitre, are more ſoluble, that is, require a ſmaller quantity of water to diſſolve them, than borax or alum; and water fully ſaturated with ſea ſalt, will ſtill take in ſome nitre, and then ſome other ſalts, and keep all equally diſſolved.

§ 114. But, theſe are not the onely ſubjects ſoluble in water: it takes in all the metalic or terreſtrial ſalts; ſuch as, all the vitriols or metals diſſolved in acid ſalts, whether of the mineral or vegetable kind. The former compoſe mineral waters of different kinds. And various ſtones or earths diſſolved in the like acids are miſcible with water; and thus our hard and petrifying waters are conſtituted.

§ 115. However, ſome exceptions lye againſt this rule: certain of the ſemimetals, by different artifices, are diſſolved in certain acids. As for example; regulus of antimony is not ſoluble in ſpirit of ſalt, in the aggregate ſtate, no more is quickſilver. But, corroſive ſublimate, which is quickſilver reduced to a vitri-

* STAHL.

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bolic or cryſtalline form, by means of ſpirit of ſalt concentrated, in ſublimation, being mixed with this regulus and deſtilled together, the acid of ſalt, from a ſtronger affinity or more powerful attraction with the regulus, quits the mercury to unite with the antimony, volatiliſes it and ſo deſtils into an ice-like ſubſtance, called, butter of antimony. This attracts the humidity of the air and is thereby diluted, in time to the conſiſtence of an heavy oil. This may be looked upon as a ſolution, or a kind of vitriol of antimony, by means of this acid; yet, it is not ſoluble in water: for, as ſoon, as this butter, or oil, as they are improperly called, is dropped into water, the reguline parts ſeparate and fall to the bottom in the form of a white magiſtery or powder, falſely called, mercurius vitae, by ſome; imagining it to be mercury, when in fact it is antimony; by others, pulvis algaroth. In like manner, Biſmuth diſſolves in the acid ſpirit of niter; and may, when diſſolved, be looked upon as a kind of liquid vitriol of that metallic. Yet, when dropped into water, it is precipitated in a white magiſtery, as well as the aforeſayed regulus.—A preſumption, that water may not be impregnated with theſe bodies, as ſome may have vanely imagined.

§ 116. The ſalts of the vegetable and animal kingdom, whether produced by nature or art, and of what kind ſoever they be, are all ſoluble in water, upon the ſame principles with the preceding. And water, charged with different ſalts, becomes a ſolvent for bodies, which, while ſimple, it could not affect: thus, charged with acid ſalts, it diſſolves various metals and earths; and, impregnated with alcaline ſalts, it becomes a ſolvent for oils, ſulphur, *&c.*

§ 117. As it may be ſatisfactory to ſome readers, I here inſert ſome tables, ſhewing the proportion of different ſalts, which a given quantity of ſimple cold water is capable of diſſolving and retaining. This method of calculation was begun by that acurate phyſician and chemiſt, the late doctor FRIDERICK HOFF-

MAN *. But, as ſome in making theſe experiments, may poſſibly find theirs differ from thoſe of this juſtly famed Profeſſor; let me here remind them of ſome defects in the making and recording of theſe experiments, and theſe are, the not determining the purity of the water and the not ſpecifying the degrees of heat or cold of that, in which theſe ſolutions were made, by ſome regular thermometer, whoſe conſtructure and ſcale was made known. Without this, there can be nothing determined with due acuracy from ſuch experiments as theſe, but little from hydroſtatical experiments upon or in water; or even in the meaſuring of it: For, as water is continually changing its temperature with the atmoſphere; as it is rarefied and expanded with heat and condenſed with cold; and as in the one ſtate, its motion is increaſed and with that, its diſſolving faculty augmented; and in the other, it is more at reſt, and conſequently leſs capable of diſſolving; the ſeveral degrees of heat or cold, before and after the adding of the ſalts, together with the purity or ſimplicity of the water, ſhould be moſt acurately determined and ſet down, in order to enable us to draw certain concluſions from the premiſes. For want of due regard to theſe cautions it is, that no two agree in the quantity of water requiſite to diſſolve a given portion of any ſalt. I ſhall, for the ſatisfaction of the reader, ſet down the obſervations of Hoffman, Juncker and Boerhaave upon this head.

* Obſ. Phyſ. Chym.

§ 118.

§ 118. HOFFMAN's table, ſhewing the proportion of water requiſite to diſſolve certain ſalts.

| | | |
|---|---|---|
| Sea-ſalt, | 4½ ounces, | Theſe ſeveral portions diſſolve, each in one pound of common water. |
| Nitre, or Saltpetre, | 6 drachms, | |
| Copperoſe, | 6 ——— | |
| Alum, | 2 ounces, | |
| Arcanum duplicatum, Tartar vitriolate, or Sal Polychreſt. | 2 ——— | |
| Epſom ſalt, | 1 pound, | |
| Fixed alcaline ſalt, | near 9 ounces. | |

§ 119. JUNCKER's table for the ſame purpoſe is carried further; thus;

| | | |
|---|---|---|
| Crude tartar powdered, | 1 drachm, | Diſſolve each in one pound of common water. |
| Arcanum dupl. or tartar vitriolate, | 1 ounce, | |
| Saltpetre, | 2 ounces, | |
| Alum, | 2 ——— | |
| Vitriol, | 4 ——— | |
| Sea-ſalt, | 6 ——— | |
| Fixed alcaline ſalt, according to its purity, | from 1 pound to 1½ pound, | |

§ 120. Theſe are both defective for want of determining the purity and temperament of the water; and give but imperfect hints, which require further improvement.

§ 121. BOERHAAVE's ſcheme is carried ſtill further and with greater accuracy. According to his

plan, the ſalts all powdered and dried, the water purified by diſtillation, and its temperament, with that of the atmoſphere, determined, by the thermometer, at thirty eight, diſſolve in the following proportion; to wit,

| | | |
|---|---|---|
| Sea ſalt, —— | 2 ounces, | in diſtilled water, 6 ounces, 3 drams. |
| Salt gem, —— | 1 ounce, | 3 ounces, 2 drams, |
| Salt ammoniac, | 1 ounce, | 3 ounces, 2 drams. |
| Saltpetre, —— | 9 drachms, | 6 ounces. |
| Borace, —— | 4 drachms, | 10 ounces and upwards. |
| Alum, —— | 1 ounce, | 14 ounces. |
| Epſom ſalt, —— | 1 ounce, | 1 $\frac{1}{2}$ ounce. |
| Fixed alcali, or ſalt of tartar, | 1 ounce, | 1 $\frac{1}{2}$ ounce. |
| Arcanum dup. or tartar vitriolate, with long and ſtrong agitation, | 4 drachms, | 3 ounces. |
| Common green vitriol by continued agitation, | 1 $\frac{1}{2}$ drachm, | 3 ounces. |
| Tartar purified, | 1 ounce, | 1 pound 8 ounces. |

§ 122. Theſe experiments may at firſt ſight appear of little moment. But, by them, we learn the different power of water in diſſolving ſeveral ſalts. Some, it diſſolves more readily, ſome, more tardily and difficultly than others; ſome in greater quantity than others. The knowledge of this is of great importance; as it ſhews us how far a given quantity of pure water is capable of being impregnated with various ſalts, and thereby greatly aſſiſts in the purification and cryſtalliſation of ſalts: As for example; if any ſalt be impure, it is to be depurated by ſolution in a ſufficient quantity of [illegible] then evaporated to dryneſs, in ſome ſorts,

till a pellicle appears on the ſurface, in others; and then, ſuffered to ſtand in a cool place to cryſtalliſe. He, that knows the quantity of water neceſſary for this purpoſe, will ſpare himſelf much expence and labor, which the ignorant of theſe rules is likely to ſuffer. Again, if two or more ſalts be mixed, as they may be, not onely in a dry form, which is eaſily conceived, but in a liquid form; for, ſeveral ſalts diſſolved may be mixed together without precipitation, or any other change; this table ſhews how they may be ſeparated; thus, ſaltpetre, ſea-ſalt, ſalt gem, ſalt ammoniac, borace, alum, Glauber's ſalt, Epſom ſalt, and the like will mix uniformly together; moreover, water ſaturated with one ſalt, is capable of receiving and diſſolving ſome of another: as for inſtance; if to the ſolution of ſea-ſalt, in the laſt table, half a drachm of ſaltpetre in powder be added, it will readily be diſſolved in it; or, if to the ſaturated ſolution of ſaltpetre, about half an ounce of ſea-ſalt be added, it will readily diſſolve therein. Or, if to the ſolution of ſea-ſalt a certain portion of alum be added it will diſſolve, when it cannot take up another grain of ſalt; and when it is thus charged, as far, as poſſible, with theſe two ſalts, it will then take in a third; for, it will diſſolve a ſmall quantity of green vitriol. Now, if any two or more of theſe ſalts were thus diſſolved together, we may hence learn how to ſeparate them: for, the ſalt, which requires moſt water to diſſolve it, will, after evaporation, firſt cryſtalliſe, and leave the others in a ſtate of ſolution, till by further evaporation, the next in order is brought to the ſame point, and ſo on. Thus, the alum will firſt cryſtalliſe, next the nitre or ſaltpetre, and the ſea-ſalt laſt. All ſalts, that are capable of being cryſtalliſed, are diſtinguiſhable by the figures of their cryſtals. It is an eſſential mark of their purity; they ſhould therefore be prefered in this form. The waſhings of diaphoretic antimony yield two kinds of ſalt; the one nitrous, the other alcaline. If this be evaporated to a dryneſs, a ſaline concrete, compoſed of

theſe two, is obtained. But, let it be evaporated by this rule, and each ſalt will be obtained ſeparately in its own proper form. In like manner, in preparing the arcanum duplicatum from nitre and vitriol diſtilled by a violent fire, or calcined together; in this preparation, the acid of the vitriol quits its own metallic baſe, to unite with the alcaline baſe of the nitre; whence, a neuter ſalt, like tartar vitriolate, is obtained; but, it may, and often does, happen, that ſome portions of the nitre and vitriol remane quite unaltered; and then, there are three ſalts in the waſhings of the calcined maſs; to wit, nitre, vitriol, and the neuter ſalt, called arcanum duplicatum. The evaporation of theſe waſhings to a dryneſs, it is plane, muſt yield a compound of theſe, not a pure, ſimple ſalt. But, cryſtalliſation, by our rule, gives each ſeparate in the order ſet down. Here, it muſt be obſerved, that all the cryſtalliſed ſalts always contain more or leſs water. To this, their coheſion and pellucidity is owing: for, diveſted of humidity, they fall into an opac powder.

§ 123. Upon the ſame principles, different ſalts, when, by any accident, they happen to be mixed, are ſeparated by mere ſolution or waſhing: thoſe, that are eaſieſt diſſolved, or require leſt water or motion to diſſolve them, will be firſt ſeiſed by the water. Thus, in ſuch a mixture, they will diſſolve in this order; 1. The fixed alcalies; 2. Epſom ſalt; 3. Sea-ſalt; and ſo on, according to the table.

§ 124. The reaſon why one ſalt is thus more ſoluble, than another, deſerves our attention. The ſalts, which conſiſt of the moſt ſubtil parts, are the leaſt ſolid, cohere moſt ſlightly and conſequently are moſt eaſily divided or diſſolved. On the other hand, the ſalts, which are compoſed of more groſs and terrene parts, are moſt denſe and ſolid, cohere more firmly together, ſo that their union is hard to be broken, and they are moſt difficult of ſolution. This is demonſtrated by the table: the ſalts of the former claſs,

which

which are found to require leſt water and leſt motion to diſſolve them, are the fixed alcaline ſalts, which have ſuch a thirſt, that when expoſed to the open air, they attract a ſufficient quantity of its humidity to diſſolve them, and then retain it ſo firmly, as to part from it with difficulty; and next to theſe, the acid ſalts, which attract and abſorb as much aqueous humidity from the air, as renders them liquid, and then retain this moiſture ſo firmly, that it is impoſſible to part them. Next to theſe, alcaline ſalts neutrated with vegetable acids, as ſalt of tartar with tartar or vinegar; ſuch neuter ſalts, as contain much water; as Epſom and Glauber's ſalts and the like, then muriatic ſalts are found the moſt ſoluble. The ſalts of the later claſs, which require moſt water and motion to diſſolve them, are nitre, alum, borace, vitriol, tartar vitriolate, and tartar. Theſe are all found of the character given, in different degrees; whence, their ſolubility varies. There is another reaſon concurs to make tartar, as it is found, almoſt inſoluble in cold water; it is all over covered with a mucid or kind of unctuous lentor, whence water without heat can hardly enter it.

§ 125. Though all oils, in their own proper nature, be abſolutely inſoluble in water, without ſome proper intermedium; yet, when they are once attenuated and ſubtiliſed by fermentation, ſo far as to become a burning ſpirit, then they imbibe and unite with ſuch a portion of water, as renders them afterwards, as ſoluble, as any ſalt in that fluid. Thus, the beſt rectified ſpirit unites upon mixture with any quantity of pure water; and the purer it is, the quicker the union. If cautiouſly poured the one upon the other, the heavier will preponderate, the lighter float upon the other; but, upon the ſlighteſt agitation, they mix moſt intimately, as before obſerved.

§ 126. Water, however, has a ſtronger attraction to divers ſalts, than to burning ſpirits. Hence, if water be perfectly ſaturated with a fixed alcali, as in the

ley, vulgarly and falſely called, oil of tartar, it will by no means quit the ſalt, to unite with the ſpirit; nor can the ley and the ſpirit be, by any artifice, united. From the ſame cauſe, if to any ſpirit diluted with water, a ſufficient quantity of dry, fixed alcaline ſalt to ſaturate the water be added, the ſalt will attract, and be attracted by, the water, they will unite and reject the ſpirit.

§ 127. But, this happens onely with ſuch ſalts, as have ſo powerful an attraction with water, that they are hardly ſeparable: for, all ſuch, as readily quit the water, from their ſuperior volatility, or aptitude to run into cryſtals, make an exception to this rule. Thus, if water be ſtrongly ſaturated with a volatile alcali, ſuch as the volatile ſalt of ſoot, urine, ſalt ammoniac or the like, which upon the ſlighteſt heat are apt to quit the water and fly off, or with ſuch as run into cryſtals, when the water is at reſt, ſuch as tartar vitriolate, Glauber's, or Epſom ſalt, upon pouring rectified ſpirit to ſtrong ſolutions of theſe kinds of ſalt, the water quits the ſalt, diſſolves or unites with the ſpirit, while the particles of the thus rejected ſalt attract each other and run into cryſtalline concretions. Hence, we ſee, that water has a ſtronger attraction with ſome ſalts, than with a burning ſpirit, and a ſtronger attraction with the ſpirit, than with certain other ſalts.

§ 128. It has been before obſerved, that burning ſpirits were but ſubtiliſed oils. Hence, they retain their affinity to oils and diſſolve all thoſe, called, eſſential; ſuch as are deſtilled in an heat not exceeding that of boiling water, from aromatic vegetables, and even thoſe, called empyreumatic or aduſt; ſuch as are drawn by the force of naked fire from vegetable and animal bodies. Thoſe obtained by expreſſion, containing ſomething mucilaginous, are not ſoluble in ſpirit. Reſins or balſams likewiſe, from their affinity to eſſential and other oils, in all which they are ſoluble,

luble, readily diſſolve in rectified ſpirits. But, water has a ſtronger attraction or nearer affinity to the ſpirit, than any of theſe. For which reaſon, as ſoon as water is poured into any ſuch ſolution, it immediately becomes opac and milky; the water and the ſpirit attract each other, unite and form a liquor incapable of diſſolving any oil or reſin; whence, theſe are rejected, and, according to their reſpective ſpecific gravities, riſe and float on the ſurface, or fall to the bottom, of the mixture.

§ 129. Oils or oily bodies are not ſoluble in water, without the interpoſition of ſome body, which has a ſtrong attraction with water, and is, at the ſame time, capable of inviſcating or breaking the coheſion of the oils. Thus, divers oils and balſams, as well as certain animal fat, that for inſtance, which is abſurdly called ſperma ceti, divided and inviſcated by the yelk of an egg become miſcible with, though not perfectly ſoluble in, water. The like effect is produced by dropping oils on ſuggar; they may, by this means, be for ſome time ſuſpended in water, which before, could not affect them. But, the moſt perfect ſolution of oils in water is effected by uniting the oils or charging the water with thoſe ſalts, which moſt ſtrongly attract water. Theſe are the fixed alcalies, and next to them, the volatile ſalts.

§ 130. The former, to wit, the fixed alcalies, unite with eſſential oils, upon being mixed dry with them and agitated; and, with expreſſed oils or fat of animals, by being reduced to a ley and boiled and ſtirred together, till the water of the ley be exhaled. Thus, the beſt ſoaps are made. Theſe ſoaps are not onely very ſoluble themſelves in water, but they render that fluid a powerful diſſolvent of various bodies, which it could not otherwiſe touch. Thus, oils and fats, and all unctuous or greaſy bodies, reſins and gummy-reſins mix with ſoap, and by that means become ſoluble in water. Hence, the cleanſing quality of ſoap. The volatile alcalies likewiſe unite with oils, and form a

kind

kind of ſoap; but, their union is not ſo permanent.

§ 131. Having thus in many inſtances ſhewn the extent of the diſſolving power of water, it is not improper to ſhew where it is limited, that it may not be looked upon in the light, in which ſome vane boaſters have placed it; that of an univerſal menſtruum or ſolvent.

§ 132. Pure water, perfectly clear of all ſalts, is not capable of diſſolving any of the metals,* though ſome men of great authority have affirmed, that the moſt pure and perfect were not proof againſt the power of this ſimple ſolvent, but may, by long trituration, be rendered actually ſoluble therein. But, the preſumption is, that if theſe gentlemen made theſe experiments, they either uſed water already tainted with ſome ſalt, or let it ſtand ſo long expoſed to the air in the time of trituration, as to imbibe enough to make it a fit menſtruum for metals moſt ſubtilly divided by grinding. However, let not this induce any one to keep water in metallic veſſels, eſpecially of lead or copper; ſince a ſlight degree of different kinds of acidity may make it capable of diſſolving enough of either to render it noxious. And all ſalts diſſolve more or leſs of copper.

§ 133. Water is not capable of diſſolving any pure earth, or ſtones, much leſs glaſs, cryſtal, or gems. Nor can it diſſolve ſulphur, even by the utmoſt heat, of which it is ſuſceptible, without the interpoſition of a certain ſalt.

§ 134. Such is the extreme penetrability of water, from the inconceivable tenuity of its parts, that it enters into the pores of a great variety of very ſolid bodies, and thereby at once increaſes their weight and ſize. This has already been ſhewn in many inſtances. Here, I ſhall only add a well known experiment to to demonſtrate the dryneſs or moiſture of the atmoſphere.

* Langelot, Homberg.

§ 135.

§ 135. Let a piece of whip-cord or cat-gut, of about a yard long, be braced upon a wall by two ſtrong hooks or nails drove into the wall. Then, let any weight, it is able to bear, be hung from the middle of this cord. And thus a barometer is conſtructed, as juſt as it is ſimple: for, every change of the air to dry or moiſt will be marked by the weight, which will be found lower in dry, and higher in wet or moiſt weather. To prove that the cord is ſhortened and the weight raiſed by water, let it be wet by rubbing a moiſt ſponge or cloth to it, it will be found to contract and raiſe any weight the apparatus is able to ſuſtain. From the ſame cauſe, fiddle-ſtrings are ſo much more tenſe in wet weather than in dry, that they frequently crack and break in the former. This, moſt certainly, is effected by the minute particles of water inſinuating themſelves into the pores and interſtices of the cord; whereby they ſhorten the dimenſions of the cord, in proportion, as they interpoſe themſelves between its fibres, as ſo many wedges would do.

§ 136. From this extreme penetrability, it is no wonder, we find ſo few bodies, to which water does not in ſome manner adhere. Various ſalts dried to the utmoſt, yield an acid ſpirit in deſtillation, whoſe fluidity is owing to water. Thus, ſea-ſalt decrepitated, even fuſed and afterwards mixed with any martial earth dried as well as poſſible, bole for inſtance, will by deſtillation in a violent fire yield a ſpirit, from which pure water is eaſily ſeparated. The ſame may alſo be ſayed of nitre.

§ 137. Sulphur, a moſt dry and combuſtible body, is yet partly compoſed of water: the proofs are, 1. That it flames in burning, and there is no flame without water; 2. That its fumes yield an acid ſpirit, if collected and condenſed in a fit recipient, from whence much water, though it muſt be confeſſed partly from the atmoſphere, may be extracted.

§ 138. An infinite number of bodies owe their ſolidity and much of their weight to water. Clay, without

out water, is but duſt; but, water being added gives it tenacity, and being moulded and baked in a kiln, conſtitutes a ware of a ſtoney hardneſs. Lime and ſand unite into a ſtoney body, that endures for ages, by the addition of water. Gypſum, or the ſtone, called plaſter of Paris, being calcined is reduced to a ſubtil powder; which, upon the addition of water, grows ſolid, dry, and hard as a ſtone. Add to this, that all our glews, ſizes, paſtes, ſtarches, *&c.* derive their tenacity from water alone.

§ 139. The moſt ponderous woods, and the moſt hard and ſolid parts of animals, as their bones, teeth, *&c.* owe the coheſion of their parts, and in ſome meaſure, their ſolidity and gravity to water. This appears upon diveſting them of their humidity, by which they all, more or leſs, loſe theſe properties. As for example; the oldeſt and dryeſt horns, bones, or teeth of animals afford a conſiderable quantity of ſpirit, as it is falſely called, and oil in deſtillation. This ſpirit is no more, than a volatile ſalt, a creature of the fire, diſſolved in the radical humidity of that animal body, which being ſeparated from it, leaves nothing, but water. The ſolid part, thus deprived of its humidity, becomes light and brittle. But, if immerged in water, it imbibes enough to reſtore, in a great meaſure, its former coheſion, ſolidity, and gravity: A proof, theſe qualities aroſe from and chiefly depended upon, water. But, could theſe like bodies be perfectly freed from water, there is reaſon to apprehend, that they would not onely be brittle, as we find them, but that they would have no coheſion at all; that is, fall into mere duſt: for, as the elementary particles of water are not onely of moſt extreme tenuity, but alſo hard, ſolid, ponderous, incompreſſible and immutable, it is not to be wondered, that they ſo firmly adhere to ſome bodies, as not to ſuffer themſelves by any means or force to be ſeparated.

§ 140. It is probable, that Water conſtitutes a part of all fluid bodies, even of thoſe, whoſe nature ſeems moſt

moſt repugnant to that of water. Thus, we ſee oils, which contain the principle of inflammability in ſuch plenty, as to be entirely combuſtible, and which abhor mixture with water; yet, of theſe, the moſt ſubtil and exalted, not onely thoſe, called eſſential, but even the burning ſpirits, contain much water. This appears, 1. From their burning, in which they all flame, which could not be, without water. 2. From their analyſis; in which all diſtilled oils and burning ſpirits yield a conſiderable quantity of water.

§ 141. Thus, we ſee water makes a conſtituent part of an infinite variety of bodies, from which it appears in its nature the moſt remote. It is confeſſedly the vehicle of nutrition and accretion to all the ſubjects of the mineral, vegetable and animal kingdoms. The hardeſt gems could not have been formed without it; and its uſe to the two other parts of the creation are too obvious to require farther illuſtration. But, it is not to be conſidered merely as a miniſtring matter; but, it is to be regarded as an eſſential part of almoſt all bodies; eſpecially thoſe of the vegetable and animal creations, into whoſe firſt formation it enters, and in which it is moſt demonſtrable. In this ſenſe, water may be conſidered, not onely as an univerſal agent in nature, but as the parent from whence many, if not all other, bodies procede. Hence, the antient chemiſts called water the Univerſal Wine, of which all the minerals, vegetables and animals drank: the reaſon of which will more clearly appear, upon taking a more ſuccinct view of the effects of water upon theſe bodies.

§ 142. It is univerſally agreed, that all bodies, even the moſt ſolid and ponderous minerals, were, ſometime, in a fluid form; which fluidity muſt have been derived from water. Great variety of foſſils are found in a liquid form in the mines. Cryſtal could never keep one certain determinate figure in its formation, nor ſhould we ever find moſs and other ſmall plants or filaments of virgin metals incloſed in it, as we frequently

quently do, had it not been ſometime liquid. The moſt accurate of our mineraliſts and metallurgiſts, of whom GEORGE AGRICOLA is the moſt eminent, aſſure us, that metals themſelves are frequently found in the mines in the form of a groſs, greaſy, ponderous, ſaline liquor, by the ſpagyriſts as well as naturaliſts, called Gur or Guhr. This form, they derive from the ſuperabundant water, with which they are diluted; as appears from their then being miſcible with, and ſoluble in, water; as all vitriolic juices and concretes are found. Hence, we ſee what a principal part water acts in the generation, increaſe, ſolution, dilution and other changes wrought in foſſils in general, in metalics in particular. To me, it appears, that water gives many of them being, as well as helps to bring on their final diſſolution.

§ 143. The part, that water acts in the production, nutrition and accretion of vegetables, is ſtill more evident, as appears from the curious experiments of VAN HELMONT, BOYLE, WOODWARD, and HALES. The pureſt water in the natural ſtate appears to be full of the ſeeds of an infinite variety of vegetables, and of the eggs of numberleſs animals. Not onely the more tender and ſucculent plants, as Hyacinths, Lilies, Mints, Gourds, *&c.* have been proved to derive their nouriſhment ſolely from water, but even trees themſelves, of a more hard, compact texture.

§ 144. The uſe and neceſſity of water to all animals, whether terreſtrious or aquatic, is no leſs evident, than it is to vegetables. To thoſe, it is not onely the vehicle of nutrition, as well as to theſe; but it likewiſe inſinuates itſelf into the frame of the moſt ſolid and ponderous parts of both, as before obſerved; ſo that, without it, nutrition or accretion could in no ſenſe be performed.

§ 145. Moreover, the vital functions could not long ſubſiſt in any animal, without the help of water. This it is, that furniſhes every animal with that bland, mild, ſubtil and penetrating fluid, capable of circulating throughout the veſſels of the whole frame, yea, to

paſs through the moſt cloſe and minute ſtrainers. Without water, in due proportion, to keep all the humors of the body duly fluid, circulation, and with it life muſt ceaſe. Hence, not onely the juices in an animal body, of whatſoever conſiſtence they be, ſo abound with water, that it is found to make the moſt conſiderable part thereof, but the ſolids themſelves owe their coheſion and conſiſtency, if not their origines, to water, as has been before obſerved.

§ 146. Thus, we ſee there is nothing of ſuch univerſal uſe in nature, as well as art, as water. It is the parent and nurſe of an infinite number of bodies. And, as it happens to be conducted and uſed, becomes the chief inſtrument of health and life, or of death and deſtruction. To water we owe all, that affects our ſenſes; 1. Of ſeeing, in the infinite variety of beautiful colors produced by nature or art: for that wonderful machine, the eye, repreſents objects to our ſenſes by the means of humors, compoſed chiefly of water; and the glaſſy or horney coats of the eye, muſt loſe their tranſparency, were they not kept conſtantly moiſtened with water. 2. Of ſmelling; the ſingular odors of bodies are, by means of water, collected, blended, perfected and preſerved; nor could they be conveyed to the proper organs of ſenſe, though the branches of the olfactory nerves lye almoſt naked, had not provident nature ſupplied theſe parts with humidity, at once to lubricate the parts, and to collect the odoriferous exhalation. 3. Of taſting; no body is ſapid, that does not contain water, or that is not therein ſoluble; and the bodies, which are moſt ſoluble in water, ſooneſt imprint the ſenſe of taſte upon the proper organs: whence, nature has plentifully furniſhed the mouth with water, in the ſaliva or ſpittle, partly to enable animals to diſtinguiſh things the more readily and effectually by this ſenſe: for, a dry tongue can no more taſte, than a dry eye ſee, or a dry noſe ſmell, diſtinctly. Hence, judicious taſters dilute hot liquors, when they truſt to this ſenſe to diſcern their qualities.

§ 147.

§ 147. The active powers of ſubſtances, whether nutritive or medicinal, deleterious or noxious, with regard to the animal oeconomy, would be loſſed without water. And the phyſical effects of bodies upon one another are owing to the ſame cauſe: for, had not theſe ſubjects been, as we find them, ſoluble in water, they could never be conveyed to the deſtined ſcenes of action in animal bodies, nor otherwiſe act upon one another. Thus, ſolid food, were it not ſoluble in water, would prove noxious, rather than nutritive; medicines and poiſons would alike loſe their effects; cauſtic ſalts layed on the ſurface of the body, or inwardly taken would prove inactive and inoffenſive, did they not diſſolve in the humidity, that occurs to them. Salts of all kinds would mix, each with another, without any ſenſible commotion, were they not diſſolved in water. This it is, that determines their motions, cauſes contraſts, ebullitions and efferveſcencies upon the mixture of certain ſalts, either with others of oppoſite natures, with oils and ſpirits or with ſolid bodies.

§ 148. In ſhort, without water, no ſaline, mucous or gummy ſubſtance, much leſs a terrene or metallic body, could be diſſolved; and conſequently, the infinite varity of effects daily produced by ſuch like ſolutions muſt ceaſe. Bodies void of aqueous humidity can neither ſuffer fermentation nor putrefaction. Thus, any body, whoſe juice is moſt ſubject to ferment or putrify, upon being dried and kept ſo, may be preſerved incorrupt for ages; whereas, by the adding of water, or reſtoring its humidity, it becomes ſubject to either. By means of water, many bodies are ſeparated, which otherwiſe muſt remane mixed: Thus, ſalts are waſhed out of aſhes and other earths with water, and by evaporation may be reduced to a dry or cryſtalline form. And by the ſame means, oils or reſins diſſolved in burning ſpirits may be parted. But, water is not onely an inſtrument of parting certain bodies, but alſo that of uniting others; as may be collected from the premiſes;

premiſes; ſince it is plane, that by the interpoſition of this fluid, various ſolutions are performed, and to the ſame cauſe ſtones, brick, and other earthen ware, bones, horns, and ſhells of animals owe their hard and firm conſiſtency, with much of their gravity. In fine, water is a moſt uſeful agent in chemiſtry; for, without it, the material operations of ſolution, extraction, cryſtalliſation, precipitation and humid diſtillation can not be performed: Add to this, the great importance of meaſuring heat with an eaſe and exactneſs unknown to the antients, by the means of water and a thermometer; by which all the degrees, between the freeſing point, thirty two, and two hundred and twelve, the boiling heat of water, beyond which it can not be raiſed, are readily aſcertained for every purpoſe of the curious operator.

§ 149. Having given this general idea of the nature and properties of common water; it may not be judged improper to enter into a more particular examination of this fluid, whoſe juſt uſe and choice is of ſuch great importance in the oeconomy of life.

### *The trials and choice of ſimple water.*

§ 150. Having thus given a general view of the nature and properties of water, it is eaſy to conceive why, and upon what principles, it becomes ſo univerſally uſeful and neceſſary in the works of nature and art.

§ 151. But, as we meet with an almoſt infinite variety of water, from its almoſt unbounded diſſolving faculty; it is neceſſary to point out the diverſity, whence it ariſes, how it is to be diſtinguiſhed, and what kinds of water are moſt fit for the principal purpoſes of life.

§ 152. Nature early teaches us to diſtinguiſh waters by the common teſt of our ſenſes: 1. We look upon no water to be pure or ſimple, that does not upon ſight appear, pellucid or clear, and colorleſs; and the more clear and colorleſs it is, the better we juſtly

pronounce it. Such water upon ſtanding lets fall no ſediment. 2. No water can be thought pure, but ſuch as is perfectly inodorous. 3. No water can be pure, that is not quite inſipid; though ſome inſipid waters are far from pure: moſt terrene or petrifying waters are taſteleſs. 4. The pureſt water makes the greateſt noiſe, when poured out of one veſſel into another. 5. The pureſt water wets ſooneſt and moſt, and feels ſofteſt to the touch. But, though theſe be the firſt trials to be made on water, as the ſenſes differ in moſt men, we are not to truſt ſolely to them; they onely ſerve to guide us to the proper and concluſive trials.

§ 153. Various artificers and ruſtics have certain teſts, by which they prove waters fit or unfit for their ſeveral purpoſes. They commonly diſtinguiſh them into hard and ſoft waters. The hard waters are ſuch as are charged with ſome terrene or ſtony or metalic matter; ſuch as the waters of ſome ſprings and moſt wells or pumps; the ſoft are rain, ſnow, ſome ſprings, moſt rivers, lakes and ponds. The hard are unfit for the watering of plants; whereas the light and ſoft fertiliſe the earth, promote vegetation and nouriſh all vegetables. Wherefore, prudent gardeners, in defect of rain or ſoft river water, expoſe their hard waters ſome time to the air and ſun, in order to ſoften them, by promoting a ſeparation of thoſe terrene or other matters, which rendered them hard. Theſe hard waters are unfit for waſhing or bleaching, brewing, baking, or boiling of food, whether animal or vegetable; being already ſo charged and clogged with terrene and other foregne matters, that they can not penetrate, and reſolve the connection of, other bodies, till they be firſt freed from the extraneous impurity. Wherefore, waſhers, bleachers, brewers, bakers, cooks, &c. chooſe the ſofteſt waters for their purpoſes. The firſt commonly know how to ſoften hard, when they can not get ſoft water: For this purpoſe, they infuſe the aſhes of burned vegetables in their

their water, whoſe alcaline ſalt diſſolves therein; by which, the acid in the water is ſaturated, which cauſes a ſpeedy ſeparation and precipitation of the terrene parts, which being, by the acid, ſuſpended in the water, obſtructed its union with ſoap and rendered it, as it is called, hard.

§ 154. Hard waters are the beſt for builders and plaſterers; as they coincide with the intention of giving firmneſs and ſtability to the mortar, by adding more of a ſimilar ſubſtance extremely fine. For want of a due regard to this, we ſee many walls but ill cemented, and plaſter crumbling and mouldering, which made with hard water, would be as firm and durable as ſtone. We have not a more common complaint, than the dampneſs of the walls of our houſes, thoſe built in great cities more eſpecially, where they are ſo negligent or ignorant of this caution, that we frequently ſee them take the waters of ſewers and the common cannals in the ſtreets, charged with ordure and other materials fit for generating nitre, and build walls with them, which never do, nor can thoroughly dry. This I take to be one of the cauſes of fires being ſo eaſily communicated from one houſe to another in our capital.

§ 155. For all the other purpoſes of life, whether for dilution or nutrition, for the boiling our foods of all kinds, eſpecially for the reſolving of horns or bones of animals; for brewing or infuſing of any vegetables; for baking the lighteſt fermented bread; for waſhing of all things; for bleaching of linen, the ſofteſt water is always the beſt.

§ 156. But, no artificer requires ſo great accuracy in the choice of water, as the chemiſt. He uſes it for elixiviation, ſolution, precipitation, lotion or ablution, cryſtalliſation, diſtillation and numberleſs other operations. In which, if the water be not pure, that is, if it contains any thing foregne to his purpoſe, he is liable to endleſs errors and remedileſs deceptions.

§ 157. The waters in the natural ſtate found moſt pure are in the order in which we have ſet

them down in the beginning of this work; to wit, 1. The meteoric or atmoſpheric, as dew, rain or ſnow, gathered with the given neceſſary cautions. This is to be looked upon as a kind of natural diſtillation, whoſe purity, like that of arteficial diſtillation, depends upon the medium, through which it paſſes, and the veſſels, in which it is received. 2. The terreſtrial; as the waters of ſprings, rivers, *&c.* which being but collections of the firſt, differ from them according to the various bodies, on which they have layen, or the ſtrainers, through which they have paſſed.

§ 158. From what has already been offered, relating to the nature and properties of water, the abſurdity of imagining any, that falls under our cogniſance, being perfectly pure and homogene muſt moſt evidently appear: For, in the firſt place, it is hardly to be diveſted of air, without loſing its fluidity, or charging it with ſome other foregne matter; and if it imbibes air, it muſt take in all, that ſuch air is charged with; which may be all the bodies of the terreſtrial creation, in different forms and proportions. However, as bodies muſt be divided to an inconceivable tenuity, to enable them to be ſuſpended in that moſt light fluid, air; ſuch waters as contain moſt air, of all others are found the lighteſt and pureſt: For, ſuch waters, as have their interſtices filled with groſs, heavy, ſaline or other terrene bodies, contain but little air, and are therefore the moſt ponderous. Thus, we find the alcaline ley of tartar, abſurdly called oil, and the acid of vitroil, as improperly called ſo; both being none other than water ſaturated with different ſalts; theſe contain little or none air; as do waters charged with other ſalts or earths, as the waters of ſalt ſprings or the ſea, and petrifying waters, in proportion.

§ 159. Hence, the lighteſt waters moſt readily conceive igneous motion, as well as moſt ſuddenly loſe it. That is, are moſt quickly heated and the

ſooneſt

ſooneſt cool and freeſe. It is hard to bring ley of tartar to boil, ſtill harder to bring the heavy acid of vitriol to boil, and in proportion, ſuch waters, as are charged with other groſs matters, whether ſalts or earths. Theſe alſo, when once heated, moſt ſlowly cool, and hardly freeſe. The truth of the laſt obſervation is known to Millers and Fullers in Germany; who are fond of having their machines upon a ſpring or other ſtream of ſuch waters, as are never known to freeſe, though they know not the cauſe. Theſe, I have obſerved to be of the petrifying kind. Of which, the moſt remarkable, that I have ſeen, are, a pretty large rivulet near Aken or Aix la Chapelle, on which there are ſome conſiderable Fulling-mills, and a large ſpring near Malmendy, whoſe waters are turned to the wheel of a mill, for grinding bark for the tanners, in hard weather, to prevent freeſing.

§ 160. As the leſt terreſtrial water is the lighteſt and the moſt readily ſet in motion, ſo it muſt neceſſarily be the moſt volatile. Hence, expoſed to the open air, it is moſt apt to evaporate, and in diſtillation riſes the ſooneſt.

§ 161. The ligheſt water is proved not onely by theſe marks, but by ſtatical experiments; for, ſome waters appear lighter or heavier than others upon the balance. But, to make theſe trials with due accuracy, it is neceſſary to examine the waters to be compared in the ſame degree of temperature, either hot or cold. For, as water is capable of extreme rarefaction by heat, and conſiderable condenſation by cold, nothing can with certainty be determined by hydroſtatical experiments, without aſcertaining by the thermometer preciſely the degrees of heat or cold of the water, at the time of making ſuch experiments.

§ 162. As water then is capable of receiving into it's pores or the interſtices of it's parts, not onely much air, but alſo great variety of ſalts and other terrene bodies, without ſenſibly increaſing it's volume; ſo the water, that contains moſt air is always found

the lighteſt; as that which is moſt charged with terreſtreity muſt be found to contain leſt air and to appear ſtatically the moſt ponderous.

§ 163. Theſe trials may be made various ways. If for example, two or more glaſſes of equal dimenſions be filled with different ſimple waters, ſuch as rain, ſpring, well, river or other waters, all of the ſame degree of heat or cold, and placed under the large receiver of an air-pump; the lighteſt water will ſhew, and part with its air, ſooner and in greater quantity, than the heavier. And the water, which is thus found to contain moſt air, may be pronounced the lighteſt and beſt.

§ 164. This experiment may likewiſe be made by the common Hydrometer, which is a machine, that conſiſts of a round hollow bulb, to one ſide of which, there is placed a round, ſquare or flat index, of three or four inches long, graduated, and oppoſite to it, a weight, to balance the index, is fixed. This may be made of metal, ivory or glaſs, the later of which, I think the beſt, as it wets more freely, and conſequently gives leſs reſiſtance in paſſing through the water, than any poliſhed metal, bone or wood; and the weight, or balance of quickſilver. When this machine is thrown into any liquor, the heavier part of it moſt inclines to preponderate. This being the balance, the index is kept upright, and the bulb ſinks deeper, or riſes higher, in proportion to the levity or gravity of the liquor. And the degree may be noted on the index. The water or other liquor, in which this ſinks the loweſt, is the lighteſt, and ſo on the contrary. But, to compare any two liquors together, care is to be taken, that they be cold or hot in the ſame degree; otherwiſe, the trials will be liable to great incertainty for the reaſons before made obvious. That water, in which this machine ſinks loweſt in the greateſt cold above freeſing, is the lighteſt and beſt.

§ 165. Waters may alſo be compared with ſufficient exactneſs by a common, juſt pair of ſcales: Thus;

Thus; Let a ſtrong glaſs phial be made, to contain about two ounces, with a ſmall mouth, to which a ſtopple is exactly adapted by grinding. Let this phial be filled by immerſion in any water to be tried; then preſſing in the ſtopple, as far as it can go, without violence, let it be quickly dried on the outſide, and exactly weighed. This will ſenſibly ſhew the difference between any two or more waters, of the ſame temperature, compared. That, which is found to weigh the leſt, is the beſt, becauſe the lighteſt, conſequently, the moſt pure, water.

§ 166. The meteoric waters may alſo be compared to the terreſtrial in any particular place or ſeaſon by the following experiment;

§ 167. Let any quantity of pure dry alcaline ſalt, one pound for inſtance, be taken and equally divided into two parts. Let the one be diſſolved, by expoſing it to the open air, and abſorbing the humidity thereof, where it may be left ſubject to receive duſt or other foulneſs. Let the increaſe be marked by meaſure and weight. Let it then be evaporated to a dryneſs, and let the proceſs of thus diſſolving and evaporating be repeted ſeveral times. Then, let the ſalt, well dried, as at firſt, be exactly weighed, and the increaſe, if any, be marked.

§ 168. Let the other portion of ſalt be diſſolved in a ſufficient quantity of any water to be compared to the meteoric, noting the quantity with exactneſs, that the proportion of this water to that abſorbed from the atmoſphere, be with due accuracy aſcertained. Let this ſolution like the former be carefully evaporated to a dryneſs, aud the proceſs of ſolution and evaporation be repeted in this, as in that, and at laſt, the ſalt dried, as at the firſt. Then, let it be weighed and its increaſe accurately noted. Whatever either has increaſed in weight, it muſt have gained it from the water, in which it was diſſolved; if the experiments were performed with care and cleanlineſs. And upon compariſon the different purity or impurity of the ſolvent,

with its proportions, will be exactly known. The portion of ſalt, which received the greateſt increaſe, or otherwiſe ſuffered the greateſt change, denominates the moſt impure water.

§ 169. By this means alſo any two terreſtrial waters may be compared.

§ 170. This may be a more certain method of determining the quantity of ſolid contents diſſolved in any water, than ſimple evaporation by itſelf. For, many particles of terrene matter may be ſuſpended, ſo united with the water, as to fly off with it in vapor; whoſe connection with that fluid may be ſo broken, by the interpoſition of this ſalt, that they may be more eaſily ſeparated; ſo that the water may be purely exhaled and leave its earthy companion, as well as ſome portion of its acid, mixed with the alcaline ſalt.

§ 171. The chemic art has, as yet, found out no means, by which terrene bodies may be diſſolved and ſuſpended in water, but by the interpoſition of ſalts, and theſe chiefly acid. It is true, BECHER tells us of a volatile mineral ſpirit, that bears no mark of acidity, but is purely inſipid; which nevertheleſs, is found capable of diſſolving, not onely earths, but metals. This our learned author diſcovered in blew clay. And, from thence, ſays, he was able to extract it by diſtillation: For, he informs us, that it tranſcends the helm with the ſlighteſt heat, and in an advanced degree, may be diſtinguiſhed from the water contained in the clay, by its diſtilling in little ſtriae or venes, like vinous ſpirits, along the inſide of glaſs diſtilling veſſels.

§ 172. If the exiſtence of this ſpirit were once fairly proved, we might eaſily account for the almoſt infinite impregnations of water with metallic and other earthy bodies, which daily occur to us. We might alſo conceive, whence the extraordinary medicinal virtues aſcribed to certain newly diſcovered ſprings of inſipid water, which in time are found quite effete and

uſe-

uſeleſs, might ariſe. But, why this ſpirit, whoſe exiſtence and power, I do not pretend to queſtion, ſhould be diveſted of the acid character entirely, is the doubt, in which I heſitate. That it is extremely volatile, I agree; for, we often ſee it fly off in the boiling and leave the water milky, with the precipitating earth, which it had before ſuſpended. Yea, fly off upon ſtanding in the open air, ſo as to let go the earth and leave the water, which it had before rendered terrene and hard, ſimple and ſoft. And, that it can not be well collected without ſuch a quantity of ſimple water to dilute it, as muſt render it inſipid, I can, without much difficulty, conceive. But, that it is no more, than the univerſal acid, more pure and exalted, than we commonly extract it from other minerals or metallics, I am induced to believe, from the following, among other, conſiderations;

§ 173. The moſt inſipid terreſtrial waters to be met with, that contain any terrene or metallic matters, part with them upon the addition of fixed alcaline ſalts; which, by the rules of chemiſtry and natural philoſophy, is thus explaned; The terrene or metallic body in the water, was diſſolved and ſuſpended therein, by the interpoſition of a body, that had a ſtrong attraction with theſe ſubſtances; thoſe, that have the ſtrongeſt attraction, we know of, with ſuch ſubſtances, are the ſeveral kinds of acids; all theſe, in different proportions, modifications and manners, diſſolve all metals, metallics and other terrene matters. When then, an alcaline ſalt is thrown into ſuch a ſolution, or a water, with any ſuch matter thus impregnated, the effect is a breach of the former combination and the production of a new one; which is accounted for in this manner, by our modern ſyſtems of Chemiſtry and Philoſophy:——The mutual attraction, which is judged to ariſe from the ſimilarity or affinity of bodies, betwixt the acid and the earthy bodies cauſed a diſſolution and union of them. This union is broken upon the adding a third body, which has a ſtronger

ſtronger attraction to one or other of the diſſolved bodies, than they had to each other. This is the alcaline ſalt, which has the moſt powerful attraction to all acids. As ſoon then, as it is thrown into any water, I have yet ſeen or heard of, which is impregnated with any terrene matter, ſo ſoon, the mixture grows turbid and lets fall a ſubtil powder, by the chemiſts called, a precipitate, or magiſtery. The evident cauſe of which is the more powerful attraction between the alcali and acid, than between the terrene body and the acid; whence, a new combination ariſes, a neuter ſalt, from the union of the acid and alcali, a mixture no longer capable of diſſolving or ſuſpending metals, metalics or mere terrene bodies; whence, all ſuch, from their ſpecific gravity, preponderate and precipitate.

§ 174. Upon this principle it is, that we diſcover a great variety of bodies in waters merely by the addition of other bodies; and at laſt, determine the nature of the acid, in which the firſt and all the ſucceding bodies were diſſolved.

§ 175. The order of this attractive power, as it is demonſtrated in Chemiſtry, is as follows;

§ 176. 1. All metallic bodies diſſolved in acids, the mineral acids eſpecially, are precipitated, firſt, by all the abſorbent earths; ſuch as lime, chalk, crabs eyes, &c. When the ſolution is ſaturated with theſe earths, it then bears no relation to the metallic ſubſtances; they are precipitated, and the liquor is charged onely with theſe earths. Then, ſecondly, theſe earths are all precipitated by volatile alcalies; ſuch as ſalt or ſpirit of blood, urine, hart's horn, or any animal body. And then the reſult is a terrene magiſtery at bottom, and the liquor is charged no more with earth, but with a kind of ſalt ammoniac; that is, a volatile alcali ſaturated with a mineral acid; if it be the acid of ſea ſalt, it will be true ſalt ammoniac; if the acid of nitre, a ſalt partaking of the nature of ſalt ammoniac and common nitre; if the acid of vitriol,

or

or the univerſal acid, the ſal ammoniacum ſecretum of Glauber. Thirdly, The connection of any of theſe is broken, by adding what has ſtill a ſtronger attraction with any of theſe acids, than the volatile alcali had. This is found to be a fixed alcali; upon the mixture of which with the former ſolution, an union ariſes between it and the acid; whereby, the volatile alcali being ſet at liberty, by its volatility, makes its eſcape in the open air. The reſult of which is another kind of neuter ſalt, differing according to the nature of the acid, as the ammoniacal ſalts were found in the laſt preceding obſervation. Thus, for example, an union of a fixed alcali with the marine acid, produces a ſalt, like ſea ſalt; with acid of nitre, ſalt petre, or common nitre is regenerated; with the vitriolic acid, arcanum duplicatum or tartar vitriolate is produced. The moſt powerful attraction then in theſe ſubſtances lyes between the acid and the fixed alcali, the ſecond between the acid and the volatile alcali, and ſo of the reſt.

§ 177. 2. But, to be more particular; We have already ſayed, that the metals, as well as earths, are ſoluble in the mineral acids, which is ſuppoſed to be cauſed by attraction; of which there are different degrees between the different metals and acids, as determined by chemical experiments; the knowledge of which tends greatly to facilitate our examinations of water and to give us clear conceptions of the compoſitions, as well as decompoſitions, that are daily produced by nature and art in this way. As for Example;

§ 178. 3. The more noble metals, as gold and ſilver are leſs attracted by the ſeveral acids capable of diſſolving them, than the baſer metals; theſe are leſs attracted than the abſorbent earths; theſe earths, leſs than the volatile alcalies, and the volatile ſtill leſs than the fixed; ſo that theſe precipitate each other in the following order; — ſilver diſſolves in the acid of nitre, commonly called the ſpirit of nitre, vulgarly aqua

aqua fortis; ſo do mercury or quickſilver, lead, copper, iron, zinc; abſorbent earths, and volatile and fixed alcalies. If then to the ſolution of ſilver, diluted with diſtilled water, you add quickſilver, the ſilver will be precipitated and the quickſilver diſſolved. If more quickſilver be added, than the ſolvent is capable of diſſolving, then a ſhrub-like concretion of cryſtals, called Arbor Dianae, or Philoſophorum, Diana's or the Philoſopher's tree, is produced. If to the ſolution of quickſilver, you add plated or granulated lead, the quickſilver will be precipitated and the lead diſſolved; If to this ſolution of lead, thin plates, wire or filings of copper be added, the lead will fall to the bottom in form of a white powder, and the copper will diſſolve and give a ſky blew tincture to the ſolution; if to this ſolution, clean, fine wire or filings of iron be immerged, the acid will attack the iron, and quit and let fall the copper in its proper form; If to this ſolution of iron, granulated or filed zinc or ſpelter be added, this will be diſſolved, and that precipitated; If to this ſolution, an abſorbent earth be added, the ſolvent will quit the metalic and diſſolve the terrene body; this terrene ſolution, will be precipitated, upon the addition of a volatile alcali; this volatile alcali will be ſet at liberty, and fly off in its original ſhape and form, upon the addition of a fixed alcali, and the acid of nitre thus recovering its alcaline baſe is again by evaporation reſtored to its priſtine form and quality; common nitre or ſalt-petre. The attraction then ſtands in an inverted order to that which we have ſet down for theſe precipitations or decompoſitions. Thus, the ſtrongeſt attraction is between the mineral acid and the fixed alcali; the next, between the acid and the volatile alcali; the third, between the acid and the abſorbent earth; the fourth, between the acid and the zinc; the fiveth, to the iron; and ſo to the reſt.

§ 179. The like order holds good in the attraction between the vitriolic acid and theſe bodies; and as this is the moſt common acid, and that, in which we find

find moſt metals and metallic ſubſtances diſſolved in the bowels of the earth, as well as ſtones and earths themſelves, I ſhall ſet it down and ſhew the reſult of the various impregnations and decompoſitions with it produced.

§ 180. To this acid, we owe a great variety of compoſitions and combinations of bodies in nature, as well as by art. The ſubſtance, with which it has the ſtrongeſt affinity known, is the inflammable principle of bodies, that, to which vegetable and animal bodies owe their oily or combuſtible quality, and to which metals are indebted for their luſtre, ductility, malleability, *&c.* For, without it, they are all but calces, as the chemiſts call them, incoherent earths; as by reſtoring it, they regain their fuſibility, ſplendor, ductility, malleability, *&c.* When theſe two principles, the univerſal acid and the Phlogiſton, in an highly ſubtiliſed ſtate, are brought into contact, they moſt powerfully attract each other and form that concrete, called ſulphur or brimſtone. Here, is its ſtrongeſt and firſt attraction.

§ 181. The ſecond, is with fixed alcalies; with the mineral fixed alcali, the baſis of ſea ſalt, it forms that concrete, called Glauber's ſalt, from the inventer's name *; with the vegetable fixed alcalies, this acid forms tartar vitriolate, arcanum duplicatum, or ſal polychreſt; for, they are all one, when rightly prepared and perfectly purified.

§ 182. The third, is with volatile alcalies; with which it forms a kind of ſal ammoniac, firſt deſcribed by Glauber and taking his name.

§ 183. The fourth is with earths, ſome kinds of which it holds intimately diſſolved in the form of a

* This ſalt is common in many waters; there is no purging water without it, in one form or other: It paſſes with many, if not with moſt, of our writers, for nitre, from the reſemblance of form. Even the great Dr. LISTER took it for nitre; but, well obſerving the difference, gave it a diſtinguiſhing epithet, though of no ſignification; he called it, Nitrum calcarium, in which he is followed by many.

ſalt,

ſalt, as alum; whileſt with thoſe, called abſorbent eſpecially, when diluted in a ſufficient quantity of water, it forms another concrete; which, while diluted, it ſuſpends; otherwiſe, it lets fall that ſubſtance, which is called Selenites, Aphroſelenus, and by ſome, Sal Selenites, from its reſemblance to a ſalt in every thing, but ſolubility, after it is once formed. To this combination, it is more than probable, Gypſum or Plaſter of Paris, Talc, Muſcovy glaſs, Spar, *&c.* owe their origine. Many waters are charged with ſelenite; as thoſe of Pyrmont, Spa, *&c.* and others, with different other ſtoney or earthy matters, as all the petrifying and other hard waters. To this quality, the obſtructing and fouling of the glands, particularly that, called the Thyroide, which brings on the ſwelling under the chops, called Bronchocele, ſo common at the feet of the Alpes and other mountanes in Switzerland; where the waters of the aqueduct of Arcueille are much drank, in Paris; among thoſe, who drink much of the wells in Rheims, or of the Pouhon, at Spa; as all the common people do, to whom it ſerves for ordinary beverage.

§ 184. The fiveth degree of attractive power of the univerſal acid is with iron. Hence, the aptneſs of this metal to corrode or ruſt in the open air, by attracting this acid. Hence, the ſlatey concretions found about mines, thoſe of coal particularly, which expoſed to the air, moulder into duſt, which taſtes, auſtere, ſubacid or vitriolic, containing iron; which, with this acid, forms vitriol of iron, green copperoſe. From an union of this acid with iron and the inflammable principle, phlogiſton, that concrete called, by the greeks πυρίτης, Pyrites, that is, the Fire-ſtone; either becauſe it ſtrikes fire by percuſſion, like a flint; or becauſe, expoſed to the air in heaps, it conceives fire and burns. This conſiſts of ſulphur and iron, with abundance of the acid, as appears by chemical analyſis. The concentrated acid of vitriol attracts the humidity of the air; by which, ſuch an agitation,

ſuch

ſuch an attrition of the parts is excited, as produces heat, and in this concrete, kindles the inflammable principle into actual fire. Hence, the Pyrite becomes the chief, if not the ſole, cauſe of ſubterranean heat and fire; by its means, ſome waters are heated, others impregnated onely, and others impregnated and heated; As ſhall be ſpoken to more at large, in treating of the mineral waters.

§ 185. The ſixth degree of attraction is with copper. This metal is ſoluble by all the ſalts. It is ſo, by this acid, and with it forms the natural Aerugo, or verdigriſe, found in the mines, as alſo blew vitriol and other ſimilar concretes. Many waters are ſtrongly charged with copper by means of this acid; As in divers mines in Hungary, Germany, and in one in Ireland, from whence the copper is ſeparated by means of iron.

§ 186. Its laſt and remoteſt degrees of attraction are with the noble metals; but, as it does not diſſolve them, without ſome particular management of art, which is not found in nature, it is foregne to our purpoſe to do more than glance at them in this place.

§ 187. Here, we have ſhewn what bodies are moſt likely to be diſſolved in water, by means of this acid, and how. Now, to ſhew partly how they may be diſcovered, or ſeparated, and partly to prove and illuſtrate our rule, let us invert the order, and ſee the reſult.

§ 188. Let us begin with one of the pure or perfect metals. If ſilver be diſſolved in the acid of nitre, it may be precipitated, with the acid of ſalt, in the form of a magiſtery, which when fuſed and cooled, becomes an horney ſubſtance, called Luna cornua. It may, in like manner and form, be precipitated, by the vitriolic acid. If to the magiſtery, thus precipitated, a ſufficient quantity of this acid be added, it will be rediſſolved in it. So ſhall a ſolution of ſilver in the acid of vitriol be obtained. *

§ 189. If, in this or the former ſolution, thin plates, wire, or filings of copper be immerged, the ſilver will be

* STAHL de vitriol. elog.

pre-

precipitated, in bright, white granules, in proportion, as the copper is attacked by the acid, and takes its place. This givs a ſolution of copper, and yields blew vitriol by cryſtalliſation, when the vitriolic acid is uſed.

§ 190. If to this ſolution of copper, wire, thin plates, or filings of iron be added, that moſt ſoluble metal will be forſaken by the acid, which engages and diſſolves the iron. Thus, copper may be extracted in its pure, natural form, from any waters impregnated with it. This has been imagined a tranſmutation; becauſe copper is found, not onely in the place of the iron, but if the ſolution of copper be duly diluted, the concretion of copper, will be found of the preciſe form and make of the piece of iron, whoſe place it took. This is but a miſtaken notion, like many others, that prevale, for want of a competent knowledge in chemiſtry; For, this is no more, than a precipitation of copper, and a ſolution of iron, upon the principles layed down. The proof of which appears by evaporating the ſolution of iron, whence the copper was precipitated: For, by this means, the iron will be found in the form of copperoſe, if the firſt ſolution was made in the vitriolic acid:—An uſeful hint for the Iriſh copper miners, who throw away their water thus charged with iron, as they till lately did thoſe impregnated with copper.

§ 191. If, to this ſolution of iron, granulated zinc be added, the acid will quit the iron, and diſſolve the zinc; which ſolution, if made by the vitriolic acid, will give white, as the preceding gave green, vitriol or copperoſe.

§ 192. If to this ſolution, well diluted, abſorbent earths be added, the zinc will be forſaken by the acid, which encounters and diſſolves the earth; but, if the vitriolic acid be uſed, and it be not well diluted, a ſelenite will at the ſame time be formed, and precipitate alſo. This will be an hard, and petrifying water.

§ 193. If to this ſolution of any abſorbent earth, or ſuch like charged and hard water, any volatile alcali be added, a milky opacity enſues, and the ter-

rene parts are ſoon after precipitated, leaving the water impregnated with Glauber's ſecret ſalt ammoniac; which may be extracted by cryſtalliſation.

§ 194. If to this ammoniacal ſolution, a fixed alcali from the mineral kingdom be added, the volatile alcali will be ſet at liberty, by the union of the acid with the fixed alcali, to which it has the ſtrongeſt attraction; the reſult of which union is the expulſion of the volatile alcali, and the production of Glauber's ſalt, the Nitrum calcarium of LISTER and others.

§ 195. If to this ſolution of this neutral ſalt, or to a ſolution of Epſom or Glauber's ſalt, a fixed vegetable alcali be added, the mineral alcali will be precipitated in the form of a white magiſtery, the magneſia alba of the ſhops, from the ſtronger attraction of this acid to the vegetable, than to the mineral, fixed alcali. This liquor then freed from the magneſia alba, contains a neuter ſalt of an other kind, which it yields upon evaporation in cryſtals; Tartar vitriolate, arcanum duplicatum, or ſal polychreſt. This ſhews the manner of producing theſe like compoſitions, the degrees of attraction or affinity, theſe different ſubſtances bear to each other. And nothing can contribute more to a true knowledge of the nature of all ſorts of water, than being perfectly acquainted with theſe rules. But, though it may, in ſome ſort, be thought foregne to our purpoſe, at firſt ſight; I muſt procede to prove my firſt poſition with regard to the attraction of the acid and the phlogiſtic principle.

§ 196. The laſt mentioned neuter ſalt appears to conſiſt of a vegetable alcaline baſe and the vitriolic acid; as the laſt but one appears compoſed of the ſame acid, with the mineral fixed alcali to its baſe. Now, if to either of theſe, a ſubſtance be added, which has a ſtronger attraction with either the alcali or acid, than they have to each other, a decompoſition or diſunion of this concrete, and a third ſubſtance, differing from both, will be produced. This is done by fuſing Glauber's ſalt by itſelf, or tartar vitriolate,

which is not by itſelf fuſible, with the addition of a little fixed alcali: If to either of theſe in fuſion, be added any vegetable or animal body, burned in a cloſe veſſel, or ſo as the air had none acceſs, ſuch as charcoal or ivory black, and then fuſed together cloſe covered for a while; the univerſal acid will quit the alcaline baſe to attract and unite with the phlogiſton, with which it conſtitutes another kind of body, which is ſulphur: For, by pouring water upon the black or dark brown maſs, which is the reſult of this mixture and fuſion of theſe neuter ſalts, with bodies replete with the pure inflammable principle, as charcoal, &c. a ſolution of ſulphur, by the means of the alcaline ſalt, which alone could render it ſoluble in water, is produced. Thus, water may be impregnated with ſulphur; not otherwiſe: For, water can not be actually, or ſubſtantially, charged with ſulphur, without the interpoſition of an alcali. Hence, the abſurdity of thoſe, who contend for the exiſtence or ſolution of ſulphur, where no ſalt or a neuter ſalt onely, not an alcaline one, is found in the waters; or what is ſtill more inconſiſtent, who look for ſulphur in thoſe waters, in which an heavy acid predominates, muſt appear; as it muſt alſo from the following conſiderations, which, at the ſame time, prove ſulphur generated by the above union of the acid and phlogiſton.

§ 197. 1. The above maſs ſmells ſtrong of ſulphur, though each ingredient before mixture, was ſcentleſs.

§ 198. 2. It grows moiſt and partly flows in the air, and diſſolves alſo in water, to which it gives a yellow color, ſtrong ſmell, and bitter taſte, and the quality of tinging ſilver firſt yellow, and then of all the colors.

§ 199. 3. If to this ſolution, purified by ſtraining, as much of any acid be added, as may ſaturate the alcaline ſalt, now in ſome degree ſet at liberty, by the vitriolic acid's quitting it, to unite with the phlogiſton; If, I ſay, to a pure ſolution of this maſs in water,

ter, any acid be added, it will ſaturate or neutrate the alcali, and in proportion, as it produces this effect, it renders the liquor incapable of diſſolving ſulphur, or of keeping it ſuſpended when diſſolved; whence, it precipitates in form of a white powder, called magiſtery, milk, or precipitate of ſulphur. This precipitate dried and fuſed gives common brimſtone. Sulphur is ſoluble in no fluid but oil, without the interpoſition of an alcali. The later being fuſed with ſulphur, gives a ſubſtance analogous to this, called hepar ſulphuris, liver of ſulphur, from its liver color. This is ſoluble in water, ſo is crude ſulphur in lime water or any alcaline ley; and this is the onely method known, by which ſulphur is ſubſtantially diſſolved in water. And this ſolution is deſtroyed and the ſulphur precipitated by acids of all kinds, as above.

§ 200. From whence* we may, as truly, as reaſonably, conclude, that ſulphur is generated by the means mentioned; that, in t. i; manner, it is rendered, from inſoluble, ſoluble in water; that by acids, it is precipitated, and conſequently can not ſubſiſt in a ſtate of ſolution in any water, that is not charged with an alcali, much leſs in a neuter water, and leſt of all, where any acid predominates. In what manner ſulphur is contained and found in the waters of Achen or Aix la Chapelle, and why there is, and can be, none in thoſe of Bath, contrary to the received opinions, ſhall be explaned in treating of theſe waters apart. But, let this be here eſtabliſhed as an axiom, that ſulphur is not by itſelf ſoluble in water, and can be diſſolved therein by none other means known, than thoſe of alcaline ſalts or earths; whence, it becomes precipitated, when thus diſſolved, by every thing, that tends to neutrate the alcali; eſpecially, by the predominancy of acidity of any kind.

* § 196, 197, 198, 199.

§ 201. Water, by the means of acids, may be, as we often find it, impregnated with an extreme variety of mineral bodies; as divers metals, metallics, ſtones, earths, &c. in different manners and proportions; without imparting any thing remarkable to the ſenſes. Then, it paſſes for ſimple, pure water; but, the deception is diſcoverable by the rules here layed down. Thus, all bodies diſſolved in water, by means of an acid, may be precipitated and diſcovered by alcalies; whileſt, on the contrary, ſuch bodies, as are diſſolved in water, by the interpoſition of alcalies, are precipitated and determined by acids.

§ 202. Various foſſil bodies diſſolved in acids may be precipitated by other acids. Thus ſilver, though it may, by different artifices, be diſſolved, in ſome proportion, in the acids of vitriol and ſea ſalt; yet, either of theſe acids dropped into a ſolution of ſilver, in its proper ſolvent, the acid of nitre, will cauſe a precipitation of the metal in white clouds, which ſettle in a grumous ſediment. Hence, this ſolution of ſilver is uſed in the trial of waters: For, if dropped into any pure water, it makes no change, as before obſerved*; but, in water charged with the vitriolic acid, or that of ſalt, or ſalt in ſubſtance, a blewiſh cloud and white precipitate is inſtantly produced.

§ 203. The ſame holds true of quickſilver alſo; which diſſolves difficultly in the ſaline and vitriolic acids, but readily in that of nitre: Yet, a ſolution of it, in the laſt acid, is precipitated by ſea ſalt, and its acid, as well as by the various other ſubſtances ſet down in the preceding rules. Whence, it is uſed in the trial of waters for the ſame purpoſe, as ſilver.

§ 204. Lead diſſolved in the acid of nitre, or in diſtilled vinegar, is precipitated by waters, charged with theſe acids, as well as with abſorbents and alcalies. Whence, ſuch ſolutions, the latter eſpecially, are uſed to the like purpoſes with the preceding. Theſe † may

* § 178. 3. † § 202, 203, 204.

be

be conſidered as exceptions to the ordinary notions of the attractions of ſolvents and ſolvends: For, though quickſilver, ſilver, lead, regulus of antimony and tin do not ſo powerfully attract the acid of ſalt, when each are in the aggregate ſtate, as to effect a complete ſolution; yet, any of theſe, being firſt divided or diſſolved by any other ſolvent, inſtantly attracts and is attracted by the acid of ſalt, from which it is not to be ſeparated by any other acid; whence, the attraction may here be deemed the greateſt. Thus, quickſilver diſſolved in any other acid, upon the interpoſition of ſea ſalt, quits the firſt ſolvent, unites and ſublimes with the acid of ſea ſalt; and ſilver and lead, diſſolved in other acids, are precipitated by this of ſea ſalt; yet, not ſo as to become perfect magiſteries; they conſtitute the horn-like, fuſible, and volatile ſubſtances, called Luna cornua, or Saturnum cornuum.

§ 205. From the foregoing rules and obſervations, uſeful methods of examining waters may be collected. Suppoſe, for example, we take any water, whoſe purity we would prove, or whoſe compoſition we would explore; after comparing it by the balance, hydrometer, pneumatic machine or air pump, by the ſolution of alcaline ſalts in air and water, &c. to the pureſt water, that can be procured, as before directed*; let us procede to further experiments, upon the principles of ſolution and precipitation before layed down, taking in ſome from the art of dying, with which, as the ſimpleſt, we may properly begin. The effects of the various dying matters, uſed for theſe purpoſes, are to be determined by experiments, firſt in ſimple water, then in thoſe, that are variouſly impregnated with acids, with metallics or minerals, with abſorbents, alcalies, &c. noting the difference, and examining the cauſes, as well as effects.

§ 206. 1. Chemical experiments teach us, that all the blew flowers of vegetables, or their coloring juices,

* § 92, 93, 1. & ſeq.

are not changed, further than by dilution, upon mixture with pure water; whereas, with acids, they are changed to a red, and with alcalies and abſorbents, to a green color.

§ 207. To this general rule, however, ſome exceptions ſtand; ſome acids charged with certain abſorbents, as the vitriolic acid, with that earth, that produces alum, with certain metals and metalics, as iron, lead in diſtilled vinegar, not in the acid of nitre, change them into a green. Wherefore, the foregoing experiments of changing the juice or infuſion of blew flowers green, are not to be relied on, before they are confirmed by other collateral proofs.

§ 208. If, for example, any water turns green, upon mixture with ſirup of violets, we are not to conclude this change wrought by an alcali, until we have tried a portion of the water with an alcali: For, if it was an alcali, that cauſed the green color, adding an alcali to the water will work no change in it. Whereas, it will otherwiſe cauſe a commotion or precipitation of the terrene or metallic matter, which was the true cauſe.

§ 209. 2. This ambiguity is partly cleared up by the juice of tournſol, or paper died blew with it. The color of this is turned to a pale red, by acids, but preſerved, heightened, or reſtored by alcalies. Hence, we conclude, water that makes no change in ſirup of violets is neither acid nor alcaline; that, which turns red with ſirup of violets, or tournſol, contains an acid; that which turns the ſirup green, and exalts the color of the tournſol, or changes or reſtores it, from red to blew, is impregnated with an alcali.

§ 210. 3. Red roſes dried, yield in pure water a pale red or Burgundy wine-color. This is highly exalted by acids, eſpecially the mineral acids, in certain proportions; particularly by the acid of vitriol. Whereas, it turns to a pale yellow or goſling green with alcalies, and with ſolutions of iron, a compound color of a blewiſh tincture with a yellow, a kind of a dark

dark olive color, is produced. To this claſs may be added the juices or ſirups of red flowers, ſuch as red poppies, cloves, &c. the juices of red cabbage, red or bloody dock, red betes, and the like, which are not altered or exalted in color by acids, but changed to a green by abſorbent earths and alcalies.

§ 211. 4. Rubarb in pure water gives a bright yellow tincture; which acids render rather more pale; but alcalies tinge to a high red; whereas, ſolutions of iron produce much the ſame color with this infuſion, as with that of roſes.

§ 212. 5. Campechy dying wood, or logwood, gives a bright red or deep Burgundy wine-color to pure water. This is heightened to a deep crimſon by alcalies; to a deep purple, with blew vitriol; to a deep mazarine blew, with green vitriol; all which colours are deſtroyed by acids: The bright red is reduced to ſomewhat of a tawny.

213. 6. Cochinelle is an inſect, with which, by the means of the acid of nitre and tin, the modern ſcarlet dye is produced, and from which the beautiful ſcarlet pigment, called carmine, is made. The judicious dyers chooſe the water fitteſt for their purpoſe, by this drug. In pure water it yields an high red tending to the crimſon hue. This is heightened by alcalies; but brought to the ſcarlet hue by acids, and if they contain metalics or abſorbent earths, the coloring matter is precipitated.

§ 214. 7. Oak bark, leaves, juice, or excreſcences, and all the aſtringent vegetables, give but their native coloring matter in pure water. Alcalies render ſuch infuſions turbid, by cauſing a kind of precipitation of the abſorbent, or aſtringent, terrene ſubſtance of ſuch vegetables diſſolved in the water; which it likewiſe tinges of ſome ſhades of green, upon ſtanding. Acids, on the contrary, reſtrain the tinge, except in red flowers, and in ſome, precipitate or deſtroy it. The ſolutions of iron, in vitriols, &c. ſuffer that kind of precipitation by this very ſubtil, ſtyptic earth, which

produces a blew, or as the tincture and ſolution are ſtronger, is heightened to the extremity of blew, which is black; what we call ink. Wherever any ſhade of this color is produced by the infuſing any aſtringent vegetable in any water, we pronounce it chalybeate, or ferrugineous, a ſteel or iron water, and ſo procede to further trials upon that head. This color is totally deſtroyed by reſtoring both the precipitating coloring matters, the aſtringent vegetable earth and the iron, to a ſtate of ſolution, by the means of any acid. And, upon deſtroying or ſaturating this acid, with an alcali, the black color is again reſtored; not quite ſo perfect, becauſe more compound; being an other different precipitation of the iron, cauſed by the alcali.

§ 215. 8. Alcaline ſalts, volatile and fixed, in a concrete or liquid ſtate, make no alteration, ſuffer onely ſolution and mixture, in our pure water. But, in waters, charged onely with acids, an ebullition and contraſt, with the dry ſalts eſpecially, will ariſe; in waters, by means of acids charged with any foſſil body, a precipitation, which examined ſhews the nature of the matter precipitated, and a neuter ſalt, which demonſtrates the properties of the acid, are produced.

§ 216. 9. If the water contains copper, the volatile alcalies, as ſoon as they have ſaturated the acid, that held it diſſolved, will ſeiſe and diſſolve it, and produce a beautiful ſaphirine color.

§ 217. 10. Soaps ſerve to prove the purity and quality of the water.* Soaps readily, equally diſſolve in pure water; in hard, or highly charged waters, ſlowly, difficultly; and ſoon after ſeparate into grumous coagulations, the acid in the waters more ſtrongly attracting the alcali, than the oil did in the ſoap; whence, the ſoap is decompoſed; that is, the alcali quits the fat or oil in the ſoap, to unite with the acid in the water, with which, after ſeparating and precipitating the terrene matters, it forms a ſalt, as before

* § 101.

explaned,

explaned,* according to the nature of the acid. For theſe experiments, I chooſe a ſolution of ſoap made in brandy, which mixes with the water, without that commotion occaſioned by fire or agitation, which may otherwiſe be neceſſary, and which might greatly alter the nature of the water before the ſoap could be diſſolved in the common manner of making a lather.

§ 218. 11. Some uſe, what they improperly call oleum calcis, oil of lime, to try waters. This is a ſolution of lime or chalk in the acid of ſea ſalt, which is the mother or bittern. It may alſo be made with the acid of nitre. But, we meet with very few waters, in which this will cauſe any change by the preceding rules: We may obſerve, it will itſelf be decompoſed and precipitated by alcalies; as it will precipitate metals, in ſome ſtrong ſolutions. It is likewiſe precipitated in a ſaline form, that of the ſelenite, by the vitriolic acid.

§ 129. 12. If we find by the preceding trials,† room to apprehend a water contains any thing alcaline, we try it with acids, which by an ebullition with it, prove our apprehenſions juſt, and teach us to judge from the ſalt produced by the ſaturation, what alcaline ſubſtance it contains.‖ For theſe trials, we begin with the milder vegetable acids, either ſimple, as juice of oranges, lemons, &c. or fermented, as vinegar, &c. and that either ſimple, or diſtilled. From theſe, we gradually procede to the ſtronger, the mineral acids, thoſe of ſalt, nitre, and vitriol. If we find the milder acids cauſe an ebullition, we may conclude, the ſtronger muſt. Theſe are the fitteſt to determine the nature of the ſalt in the water; becauſe, the effect of their combinations with alcaline ſalts are beſt known, and eaſieſt demonſtrated. Though the ſalt produced by the union of fixed alcalies with vinegar is known by its foliated form, whence called whimſically Terra foliata tartari, the Foliated earth of tartar;

* § 176, 181.
† § 206. 1. 209. 2.
‖ § 176, 181.

in

in our ſhops, as inexpreſſively, ſal diureticus, the diuretic ſalt; as alſo by its fuſibility, volatility, and aptneſs to liquefy in the open air; qualities, which diſtinguiſh it from moſt other neuter ſalts, but are found in an inferior degree in that prepared with the mineral, to that prepared with the vegetable, fixed alcali. In like manner, the ſalt produced by ſaturating an alcaline water, with a ſolution of tartar, would be known by its ſolubility and the figure of its cryſtals, if it bore any analogy to tartarus tartariſatus or ſolubilis; a ſalt ſo called, compoſed of a fixed alcali ſaturated with the creme or cryſtals of tartar.

§ 220. 13. A ſolution of alum in ſimple water is uſeful in the examination of other waters. Alum conſiſts of a peculiar abſorbent earth diſſolved in the univerſal or vitriolic acid. This added to pure water, ſuffers no change, but ſolution. But, if the water contains any thing, that has a ſtronger attraction * to either of the conſtituent parts of alum, than they have to each other, a diſunion of theſe parts will be occaſioned and a new combination produced; each of which examined apart gives us intimations of the compoſition of the water. As for example; If a ſolution of alum, upon dropping into water cauſes white clouds and a precipitation, the inſtilling of the ſolution may be repeted till no more cloudineſs ariſes, or precipitation is cauſed by the mixture. Then, it is to be preſumed ſaturated. The precipitate being ſeparated, will be found upon examination to be the earth of the alum, whileſt its acid has formed an union with an alcaline ſalt and produced that concrete, which this acid is found to form with alcaline bodies.† But, it muſt be remembered, that in ſome caſes, the acids perform ſuch a precipitation, where the ſolution is metallic.‖ Thus, the ſolutions of ſilver and lead are precipitated by the vitriolic acid in the alum. Theſe precipitates are diſtinguiſhed from the former by this; that of ſilver readily fuſes and ſoon after

* § 118, 119, 120. † § 194, 195. ‖ § 207, 208.

flies

flies off, if continued over the fire. If it be ſuffered to cool, it yields an horney ſubſtance, called, Luna cornua. That of lead will yield ſimilar appearances; and each may be reduced to its priſtine metallic form; the one by fuſion with the black flux, ſoap, &c. the other, with the addition of a little oil or fat or charcoal duſt, will fuſe into its priſtine form, the metallic properties, loſſed in the ſolution, being reſtored with the phlogiſtic or inflammable principle.

§ 221. 14. The metallic ſolutions in different acids may all contribute their part in the examination of ſimple, as well as mineral waters, upon the principles of attraction or affinity, as before layed down;* Of each of which in their order.

§ 222. 15. Quickſilver diſſolved in the acid of nitre diluted with purified water; or the ſolution evaporated to a dryneſs, or to cryſtals, and the dry maſs, or the cryſtals diſſolved in diſtilled water, exactly noting the proportion in a given quantity of the fluid; This is one of the boaſted ſecrets, one of the much famed drops, of one of our quacks of the firſt magnitude; As any one may prove by the following experiments.

§ 223. 16. By the different degrees of attraction obſerved between other bodies and the nitrous acid, greater than between that and the quickſilver, it is eaſy to judge how many different ſubſtances, ſuſpended in water, may cauſe a precipitation therein, upon the addition of this ſolution.† Quickſilver in this form is precipitated, not onely by the various metals and metalics in the cited ſection ſet forth, but by all abſorbent earths, by alcalies, volatile and fixed; and theſe, mineral, as well as vegetable; but particularly by ſea ſalt and its acid. Hence, waters charged with theſe ſubſtances muſt precipitate the mercury in ſuch a ſolution, whenever it is dropped into them. But, they produce different colors which diſtinguiſh them; in chalybeate waters it is firſt white, then ſuddenly changes to a lemon color, or deeper yellow; the ſame

* § 175, 176, 177, and ſeq. † § 178. 3.

effect

effect is produced by waters charged by the means of the vitriolic acid, with ſimple abſorbent earths, and with fixed alcalies; in thoſe charged with abſorbent earths, and ſome lixivial and muriatic ſalts, ſtringy clouds or filaments of a pale yellowiſh hue; in waters containing a pure volatile alcali, an aſh-colored ſediment; in waters charged with fixed alcalies, a muddy yellow; in waters charged with pure ſea ſalt, a beautiful white precipitate, or rather a kind of cryſtalliſation; for, the acid of ſea ſalt, uniting with that of nitre, conſtitutes that compound mineral acid, called aqua regia, the royal water or ſolvent, from its being the onely proper ſolvent of gold, the chemiſt's King and the Idol of moſt men of what ſect or religion ſoever; this liquor is incapable of diſſolving the mercury; whence, the before diſſolved particles attracting, and being attracted by, the muriatic acid, form thoſe little cryſtals, which are ſtill ſoluble in water, conſequently no true magiſtery or precipitate. But, to the forming of this kind of precipitate, as it is called, the alcaline baſe of the ſea ſalt may contribute ſomewhat, which better deſerves the name. This ſolution of quickſilver gives a pale lemon-colored precipitate with a ſolution of Glauber's ſalt, and with that of tartar vitriolate, a turpeth mineral-colored precipitate. The knowledge of which facilitates our acquiring a juſt notion of the mixture in the water. To aſcertain which, the precipitate is to be examined apart, and the liquor, whence the ſolid matter was precipitated, is to be proved by evaporation, cryſtalliſation, &c. in order to determine what concrete it affords with the union of the acid of nitre.

§ 224. 17. Corroſive ſublimate mercury is recommended and uſed by many in the trials of waters; though, to the beſt of mine obſervation, to very little purpoſe, at leſt, to much leſs than the preceding ſolution. Sublimate is a ſolution of mercury in the concentrated acid of ſea ſalt, in which it is not ſoluble by the ordinary rules of ſolution. But, quickſilver being diſſolved in any other mineral acid, evaporated to a dryneſs, mixed with a certain proportion of ſea

ſalt, with or without calcined vitriol, or the precipitate of mercury with ſea ſalt, or its acid dried, and committed to a ſand furnace, in a convenient glaſs veſſel, upon adminiſtring the juſt degrees of heat, the acid of ſalt is ſet in motion, and by a more powerful attraction, wreſts the mercury from the acid, which held it diſſolved before, and by a quality peculiar to the acid of ſea ſalt, that of volatiliſing all metals and metallics, with which it unites, it renders the quickſilver, which is almoſt fixed by any of the other mineral acids, ſemivolatile and elevates it into a fair cryſtalline form, which may be looked upon as a kind of vitriol of mercury. This, though difficultly, diſſolves in pure water, and makes no change in it. This mixed with a burning ſpirit, is uſed internally and externally by our quacks, as Antivenereal Eſſences and Lotions. The mercury is thence precipitated in its proper form, by ſilver, by copper or braſs, and before ſolution, by regulus of antimony, and by tin. It gives a milkyneſs to water charged with ſulphur or phlogiſton. It is precipitated in form of a magiſtery by abſorbents and alcalies: The earths and the volatile alcalies give a white, and the fixed, an orange-colored precipitate. To demonſtrate the later, is its chief uſe in the trial of waters.

§ 225. 18. Lead diſſolves in every vegetable acid, but more readily when firſt corroded by the means of the vapor of a fermented acid as vinegar, whereby white lead is prepared; or when it is reduced to a calx by fire, ſuch as litharge or red lead; by which treatment the metal is in a great meaſure deprived of its phlogiſton. In this ſtate, lead is moſt ſoluble. It then diſſolves readily in all expreſſed oils, in moſt acids, in moſt fermented liquors, the aceſcent eſpecially, and partly in common water; to all which it imparts a ſaccharine ſweetneſs. The preparation, called ſugar of lead, is made by diſſolving any of theſe calces of lead in diſtilled vinegar, evaporating and cryſtalliſing it. And here, I can not omit enveighing againſt theſe fraudulent dealers in wine, who uſe theſe preparations

rations of lead to ſweeten their pricked or ſour wines; than which, nothing can produce more deadly effects. I am likewiſe prompted to inculcate a caution againſt boiling or keeping acid or fermented liquors of any kind in leaden or peuter veſſels, or baking tarts or pyes of green or ſour fruit in diſhes of theſe metals; from which cholics, cramps, convulſions, palſies, and a painful lingering death is frequently brought on. In France, the uſing lead to ſweeten their wines is puniſhed with death. Though all this muſt be confeſſed foregne to my preſent purpoſe, it can not be diſagreeable to the reader to learn a method of diſcovering, whether lead be diſſolved in wine or in any other fermented liquor. This may be done by dropping a ſolution of Hepar Sulphuris into it, which will occaſion a reddiſh brown precipitate, or what is ſtill more certain, a ſolution of orpiment with quick-lime in boiling water, or HOFFMAN's volatile tincture of ſulphur, which will cauſe a black precipitate. By conſidering the variety of bodies, that have a ſtronger attraction or affinity than lead has to this acid or that of nitre in which it diſſolves *, and the acids, as well as abſorbents and alcalies, that cauſe a precipitation of theſe ſolutions †, the uſe of a ſolution of lead in the examining waters will readily appear. The nature of the precipitate is to be proved as before obſerved ‖.

§ 226. 19. The ſolution of ſilver in its proper ſolvent, the nitrous acid, is very uſeful in the trials of waters. This diſſolves, as quickſilver does, and like that, it may be evaporated to a dryneſs or to cryſtals, either of which may be diſſolved in purified water, or the ſolution may be moderately diluted with the ſame, exactly noting the proportions uſed to avoid miſtakes in experiments and compariſons. Upon conſidering the variety of bodies, that have a more powerful attraction to the nitrous acid, than the ſilver has ‡, it is eaſy to ſee the uſe of a ſolution of ſilver

* § 178. 3. † § 204. ‖ § 220. 13. ‡ § 77. 2. 188. & ſeq.

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in the examination of waters. This ſolution dropped into the pureſt water mixes freely without making any change in it. But, if it contains the leſt veſtige, the ſlighteſt taint of thoſe foregne matters, before * ſpoken to; then, white clouds and a ſpeedy precipitation follows. The cauſe is to be found, by examining the precipitate, and the contents of the liquor, whence it was precipitated †, apart, upon the principles before layed down ‡.

§ 227. 20. Upon the ſame principles, other metallic ſolutions are uſed in the examination of waters; ſuch as thoſe of copper and iron, either in the nitrous acid, or in that of vitriol; ſuch as the ſolutions of the green and blew vitriols afford. But of each a word apart;

§ 228. 21. Copper is of all metals the moſt ſoluble. All ſalts diſſolve it, more or leſs; whence, it is not onely, in ſome meaſure and manner, ſoluble in all acids, but in all alcalies, and even in neuter ſalts, as well as in oils and ſoaps. To the different ſolvents, it imparts different colors, ſuch as different ſhades of blew and green. But, if extremely diluted, it appears colorleſs. Copper corroded by vegetable acids is of a color between a pale green and a pale blew, called verdigriſe. But, diſſolved gives a deep green tincture and cryſtals. Copper diſſolved in the vitriolic acid gives a pale ſaphir-color, in the acid of nitre, if pure, a paler blew; but if tainted with ſalt, as in aqua regia, a berill green; The ſolution, in the acid of nitre diſtilled, comes over colored green with the copper, which ſhews its volatility; diſſolved in the acid of ſalt it gives a beautiful, bright emerald color. Upon conſidering the different attractions of bodies ‖, it is eaſy to conceive how copper is precipitated from all theſe ſolutions, or its color changed in ſolution by different ſolvents. Whatever more ſtrongly attracts the acid, than the copper and the acid attract each

* § 177. 2. &c. † § 176. 1. 181, 182, 183. ‡ § 196. 224. 12. ‖ § 175 to 176.

other,

other, will ſaturate the ſolvent, as faſt as that is effected, the copper is precipitated or rather ſuſpended between the two ſolvents; but, as ſoon as the ſaturation is completed, and the acid ſolvent is by an alcali rendered neuter, then the copper is moſtly rediſſolved by the neuter ſalt; and then, if the alcali be made to predominate, it is again diſſolved in that ſalt. So that copper once ſet in ſolution, it is hardly to be totally precipitated by any means, but iron. The changes of color, it undergoes in ſhifting of ſolvents deſerve attention. The acid of ſalt added to the blew ſolutions of copper, in the nitrous or vitriolic acids, changes them to a fair graſs green. If to any of theſe ſolutions an abſorbent earth be added, a partial precipitation will be performed; If a fixed alcali, a partial precipitation will immediately enſue; but, upon ſaturation or overcharging the ſolvent with the alcali, another ſolution will enſue, but not ſo complete as the firſt; and the color becomes of an higher tinge of blew. This ſuccedes better with the volatile alcalies: Theſe, in each of the ſolutions, cauſe at firſt a partial precipitation; but, as the alcali becomes predominant, a new ſolution is inſtantly brought about; which, in the firſt and ſecond ſolutions, puts on a beautiful ſaphir-color; in the third, that of an amethyſt, all deeper or paler, as the liquor is more or leſs charged with copper. All theſe colors are again deſtroyed by acids; which, at firſt dropping in, cauſe ſome precipitation; but, as they approach to ſaturation, a rediſſolution in the neuter ſolvent enſues, and and a ſtill completer, upon the acid's becoming predominant. The moſt complete precipitant of copper known, is iron: For, this ſo ſaturates the acid ſolvent, as to leave it quite void of copper *. By theſe means, we diſcover whether a water contains copper or not. Or by the adding a ſolution of copper to any water; we may learn what cauſes the precipitation, if any enſues. All the ſolutions of copper have a moſt nauſeous, bitter, offenſive taſte, with auſterity in the acids and acrimo-

* § 193, 198.

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ny in the alcalies. In very ſmall quantities, it gives extreme ſickneſs and violent vomitings; but, in greater, it approaches very near the deleterious qualities of modern arſenic, that intractable poiſon. This, with its extraordinary ſolubility, even in the air, ſhould caution againſt the promiſcuous uſe of copper veſſels and other culinary utenſils.

§ 229. 22. Iron may alſo be uſed in the trial of waters, upon the ſame principle, with other metals. And to different ſolutions of it, we owe all our martial or ferrugineous waters, commonly called Chalybeate or Steel waters, with impropriety; as ſteel is not known in nature. Iron, though the hardeſt, is yet, next to copper, the moſt ſoluble of the metals. The acid of the air corrodes it, and few waters are known, that are not ſo replete with this acid, as to diſſolve iron. All the mineral acids, in a diluted or concentrated ſtate, attack it with great violence, heat and vapor, and diſſolve it; but, more effectually, diluted. The moſt potent and probably the proper ſolvent of iron, is the vitriolic acid. This, ſeemingly contrary to our general rule *, quits, in ſome meaſure, its favorite phlogiſton to unite with iron: For, if filings of iron and ſulphur, in flowers or powder, be mixed together and moiſtened with water, the acid of the ſulphur and the iron attract each other ſo powerfully, as by their attrition to produce an heat, ſufficient to give fire to, and totally conſume, the adherent phlogiſton; leaving the iron and the acid united; ſo as to form vitriol of iron by elixiviation or infuſion in water, evaporation and cryſtalliſation. This is a kind of artificial pyrite. Some uſe this experiment to ſhew how hot baths and ſulphureous waters are produced. But, unfortunately for theſe ſuperficial ſmatterers in phyſic and chemiſtry, ſuch a compoſition is not to be ſought in nature; becauſe, iron, in a malleable or ductile ſtate, has moſt rarely, if ever, been found in its native place. Beſides, though it had, a ſulphureous water could not be the reſult of waters paſ-

* § 180, 195. 196.

ſing through ſuch a mixture; becauſe, the ſulphur is decompoſed and one of its conſtituent parts burned and diſſipated in the operation. Iron then diſſolves freely in the vitriolic acid; if not very plentifully diluted, much of the phlogiſton of the metal flies off in a combuſtible vapor. When the ſolution is finiſhed, a black cruſt remanes, which, with moſt, has hitherto paſſed for an inſoluble earth; whereas, it is in fact ſulphur, generated by the union of the inflammable principle of the iron and the univerſal or vitriolic acid. The ſolution of iron in this acid, duly diluted, is of a pale graſs green; and evaporated and cryſtaliſed, gives pale green cryſtals, green copperoſe; or as ſome affect to call it, ſalt or vitriol of Mars or iron. This metal diſſolves in the acid of nitre and gives a dark orange colored tincture; it diſſolves in the acid of ſalt, and gives a greeniſh yellow, which ſome abſurdly impute to copper, not conſidering, that copper can not ſubſiſt in a ſolution charged with iron: It diſſolves in aqua regia and gives a yellow tincture; it diſſolves by means of tartar and gives a dark red or brown tincture; it diſſolves in diſtilled vinegar and gives ſweetiſh cryſtals; it is diſſolved by the juices of all acid or auſtere fruits or other vegetable ſubſtances, as is diſcovered by the taſte a knife gives the fruit in cutting, and the ruſt or black color on the blade, which enſues the cutting. It is not difficult to conceive how water ſhould become impregnated with this moſt common, as well as moſt excellent of all metals, when it appears ſo remarkably ſoluble. Upon conſidering the various ſubſtances, that hold a ſtronger attraction with all or any of theſe acids, than iron does *, we ſhall ſee how the addition of any of theſe to a water, impregnated with iron, will diſcover and precipitate that metal; and on the other hand, how a ſolution of this metal dropped into any water, charged with any of theſe matters, will be precipitated, and ſhew the cauſe of the preci-

* § 176. 1. 178. 3. 133. 190, 191, 192, &c. 214. 7, &c.

pitation.

pitation. Thus, for example, powder or infuſion of galls, or the like aſtringent vegetable ſubſtance, thrown into a water, by any of theſe acids impregnated with iron, will cauſe a blew or black precipitation or color; abſorbent earths, volatile or fixed alcalies, will occaſion ochrous precipitations of martial earths; or a ſolution of iron, dropped into water charged with aſtringent vegetable earths, abſorbent mineral earths, or volatile or fixed alcalies, will produce the like effects, for the like cauſes.

§ 230. But, here we muſt not omit an exception to this general rule, which will greatly facilitate our accounting for a principle or ingredient, frequently found in the moſt active chalybeate waters; as in thoſe of Pyrmont, Spa, Malmendy, Bru, &c. as ſhall be ſhewn in the proper place. It has in general been obſerved, and in the laſt article in particular, been inſiſted on, that fixed alcalies precipitate ſolutions of iron. In the general acceptation, there is nothing more certain than this; yet, an exception to it has been diſcovered by a late illuſtrious ornament * to phyſic and chemiſtry, who firſt obſerved, that if a ſtrong ſolution of any pure fixed alcali be gradually dropped into a ſolution of iron in the acid of nitre, keeping it conſtantly, quickly, and thoroughly agitated; ſo far from cauſing a precipitation, it will be found, that a perfect ſolution of this metal in a fixed alcali will enſue: For, the more of the alcaline ley is added after ſaturation, the more complete the ſolution. This ſolution no longer actually contains an acid: For, that, in which the iron was firſt diſſolved is ſaturated with the alcali in the conflict upon mixture; whence, a neuter ſalt, to wit, nitre is produced. This then, is a ſolution of iron in an alcali, which may be proved by theſe conſiderations; firſt, if the ſolutions be both concentrated or very ſtrong, part of the nitre will cryſtalliſe in its natural form, upon lying quiet in a cold place, leaving

* STAHL. opuſ. phyſico chemico-medica.

the iron diſſolved in the remaning ley; ſecondly, either the ſolution, or this remaning ley, now ſuffer a precipitation upon the addition of the weaker acids. This experiment ſuccedes beſt with a ſolution of iron in the nitrous acid. It is deemed owing to the great quantity of phlogiſton in the iron and in the acid of nitre, which ſtrongly attracts fixed alcalies, and forms with them a ſolvent, not unlike that produced upon mixing common ſulphur and a fixed alcali by fuſion: This gives the concrete, called hepar ſulphuris, which becomes a ſolvent for all the metals, gold not excepted: For, metals fuſed with hepar ſulphuris become with the maſs ſoluble in water; whence, both are precipitated by acids.

§ 231. Having thus ſhewn the means of diſcovering the kind and manner of the principal impregnations of waters with variety of matters, in the way of mixture; let us purſue the analyſis by other methods; for, all the known ways of exploring the compoſitions of water, are frequently to be called to our aid, before a thoroughly inquiſitive, rational mind can acquire full ſatisfaction.

§ 232. The ſolid contents of a water may not onely be obtained by the ways of precipitation, before * ſet forth, but alſo by evaporation; in which the connection of the aqueous and terrene parts is diverſly broken and the parts ſeparated. It has before been obſerved †, that moſt of the waters, which contain any ſolid parts, that have hitherto fallen under the cogniſance of the curious, are impregnated by means of an acid of different degrees of ſubtility and volatility; and for the moſt part, by one, as volatile, as the univerſal acid, with which the atmoſphere is charged: Hence, we find the hardeſt waters decompoſed by boiling, which cauſes the depoſing or precipitating the terrene parts, in proportion, as the acid ſolvent eſcapes. The ſame thing happens more ſlowly, when theſe waters ſtand

* § 173, 174, 175, and following. † § 171.

expoſed

expoſed for a few days to the air. This is well known to gardeners and other ruſtics, who let their hard water ſtand to ſoften, as they call it; that is, to let the acid ſolvent eſcape and the earth fall to the bottom. All waters, charged with whatſoever earthy or metallic parts they may be, ſuffer a decompoſition by theſe means. This is extremely evident in the moſt active chalybeate waters, as thoſe of Pyrmont, Spa, Malmendy, and the like, and even in thoſe of Tunbridge; all which, upon ſtanding in the open air a while, in glaſſes, cover their ſides with innumerable air bubbles; which, as faſt as they are ſeparated or eſcape, leave the water turbid, and when they are all diſperſed, let its ſolid contents, which by this means were diſſolved, fall to the bottom; the water, without this ſolvent, being incapable of diſſolving any metallic or terrene matter.

§ 233. As this volatile ſolvent, as well as the water may be exhaled from the ſolid contents; the firſt rational proceſs for the examination of waters, in this way, is by diſtillation. Let then any water, to be tried, be diſtilled, by the apparatus * for purifying water. And let the firſt runnings of it be examined by the means before directed for proving, whether it contains any and what volatile principle, beſides water. The diſtillation may be protracted, till all the fluid be drawn off, trying it from time to time from firſt to laſt, with blew paper, ſirup of violets, with acids, with alcalies, with ſolution of lead and ſilver. If theſe make no ſenſible change in it, we may preſume the diſtilled water pure, as art can make it, and that the acid has been either altered by the fire, or by its extreme ſubtility made its eſcape in the operation. I have obſerved ſome waters, which diſtilled, gave no ſenſible proof of acidity; yet, a piece of blew paper, layed in the juncture of the diſtilling veſſel, has been found in divers parts ſtained red; a full proof at once of the exiſtence and ſubtility of this acid.

* § 92 to 98.

§ 234. The ſediment, that remanes in the glaſs, is the ſolid and fixed contents of the water. But, this is not the moſt exact method of collecting it: For, the heat requiſite for diſtillation, is more than neceſſary and prejudicial in evaporation; which can hardly be done too ſlowly. Becauſe, we know by experience, that too great heat in the evaporating moſt ſalts for cryſtalliſation, ſenſibly alters them in quantity and quality. Therefore, to obtain the ſolid contents of any water, let it be ſet in a flat or low glaſs veſſel, placed over the gentle heat of the vapor of heated or boiling water, in boiling or heated water, or in an heat analogous, in a ſand furnace. Let it be layed, where no duſt or foregne exhalations can foul or otherwiſe alter it, and then let it be ſlowly evaporated to a dryneſs.

§ 235. As all, that is volatile, and that onely, eſcapes in this proceſs; the ſolid contents are thus as fairly obtained, as poſſibly may be, by art. In this ſediment, we have all the fixed, ſolid parts, that are by art ſeparable from the water; as in the diſtillation or evaporation, all that is truly volatile flies off. However, we muſt be cautious of pronouncing the proportion of ſolid contents in a given quantity of any water from what it is found to yield upon one or two trials in the way of diſtillation or evaporation: For, great variety will be occaſioned by the different degrees of heat, and the make of the veſſels, uſed in the operation. Becauſe, it is found by experiment, for which it is not eaſy to account rationally, that water, boiled in open veſſels, leaves much leſs terrene ſediment, than when it is boiled in cloſe or covered veſſels; which poſſibly may be owing to this, that the union of ſome matters, by means of this ſubtil acid diſſolved in the water, is ſuch, that, as in the tartar vitriolate, it may eſcape in the boiling; but, being reſtrained in cloſe veſſels, the ſubtil ſpirit may be firſt diſſipated and leave the ſalt or earth to ſubſide.

§ 236.

§ 236. The waters, that are leſt charged with ſolid mineral matters, muſt be the lighteſt, are ſooneſt heated, and ſooneſt cool, readieſt diſtil, and leave the ſmalleſt quantity of ſediment in evaporation. Such are the waters of Slangenbadt, of Taeplitz and Pfeffer, beforementioned, and that of Zeffen or Seffen, a moſt curious, pure, cold ſpring near Aix la chapelle, whoſe water very nearly equals that of Pfeffer in lightneſs and purity. The exception to this rule, which ſome offer from Lime-water, which appears highly charged by various experiments, yet is ſayed to leave little or nothing behind it in evaporation, is now of no force; as by more accurate experiments, it appears to be a groſs error. *

§ 237. There are few or no waters, whether meteoric or terreſtrial, known, that do not leave a conſiderable quantity of an heterogeneous maſs behind them in evaporation. To which point, we have the concurrent teſtimony of ſome of the moſt learned, induſtrious and obſervant profeſſors of chemiſtry.

§ 238. BORRICHIUS † took of limpid ſpring water, as well as that of rain, ſnow, hail and froſt, one hundred pounds and evaporated them apart, in clean glaſs veſſels, to one pint each. In this, ſome terrene feculency ſhewed itſelf, which being ſeparated by filtrating it through ſoft, porous paper, the ſtrained liquor appeared of a red color. This liquor, he committed to a clean glaſs cucurbit, ſet it in a bath-heat, and, by ſlow evaporation, reduced it to the conſiſtence and color of gely of corinths. This extract, being continued in the bath-heat, was at length reduced to a dry powder, which melted with bubbles, and overrunning its bounds, took fire and burned with a clear, bright flame, which gave proof of an oily ſubſtance. The remaning burned maſs, being waſhed with diſtilled water, yielded a ſaline ley, which gave fair, cubical cryſtals of ſea-ſalt, by evaporation, and left an

* § 57. 4.
† De Herm. et Ægypt. Sapientia.

inſipid earth behind. The extract diluted with diſtilled water gave a red tincture not ungrateful to the palate; which, being filtrated and expoſed during the ſummer months in a wide-mouthed glaſs, as the water gradually exhaled, coaleſced into ſplendid, brilliant, cubical cryſtals, in themſelves colorleſs, but interlayed with the oily coloring matter, which was inflammable. The proportion of this ſalt to the oily ſubſtance is never certain: ſometimes it is found as three to one, at others, as ten to one. The thick extract diſtilled by a retort yields firſt a ſmall portion of an oily, inflammable ſubſtance, and afterwards, ſome acid ſpirit.

§ 239. Though KUNKEL's * experiments do not exactly agree with this; yet, do they not eſſentially differ the one from the other. This moſt aſſiduous and accurate chemiſt tells us, that after evaporation of a moſt immenſe quantity of rain water, a blackiſh, ſaline earth remaned; which being much expoſed to the air and then diſtilled by a retort, yielded an acid ſpirit and an empyreumatic oil; or being ſet on fire, after the inflammable parts were conſumed, an aſh-colored, alcaline powder remaned.

§ 240. The ſeeming difference of theſe two proceſſes ſerves onely to ſhew, that rain water is very different, in certain ſeaſons and places, from what it is found in others. Indeed, it is not to be expected always of the ſame nature in any one place, however carefully it be collected; as its variation depends upon that of the atmoſphere. It is always found to contain more or leſs earth and ſalt and ſome oily matter; but, it is often charged with various other mineral matters. Some writers, extremely ſollicitous to prove a long prevaling erroneous or artful aſſertion, of certain waters containing ſulphur, think they have ſucceded in obtaining this oleo-ſaline extract † from their waters.

* Obſerv. chemic.

† § 238, 239.

But, ſurely this proves more, than they wiſh; ſince, by this rule, they muſt find themſelves hard ſet to point out a water void of ſulphur, if they deem this oily ſubſtance ſuch, from which there is hardly any water quite free.

§ 241. But, neither of theſe experiments * has the neceſſary accuracy for a perfect analyſis of water; the proportions are to be determined with the ſtricteſt exactneſs. The quantity of water uſed is to be firſt aſcertained, and the reſiduum, when carefully and cautiouſly dried, weighed with a true balance. Then, the conſtituent parts of this remaning maſs are to be enquired into and eſtabliſhed upon certain, not hypothetical, principles, and by teſts more concluſive, than the ſenſes alone can afford.

§ 242. Theſe maſſes are generally found, as well in the terreſtrial, as atmoſpheric waters, to conſiſt of different kinds of ſalts, 1. alcaline, 2. neuter, which are of different kinds, 3. earth, which is commonly of three kinds, and 4. with more or leſs of the oily ſubſtance.

§ 243. It has been obſerved before †, that ſeveral ſalts may be blended together in the ſame water. If ſo, we may look for the reſiduum after the evaporation of waters to be in general very compound; and the preceding tables ‡ furniſh hints how the different parts may be ſeparated.

§ 244. But, it rarely happens, that we find more than three different ſalts together, that can be ſeparated in a dry or concrete form, in any one water. And theſe, for the preſent laying the ſelenite aſide, are, 1. the mineral alcali, the nitre of the antients; 2. ſalt gem, or ſea ſalt; and 3. a compound of the firſt or of the baſe of the ſecond with the vitriolic acid, a ſalt bearing great analogy to that of Glauber, falſely by ſome taken for nitre, LISTER's nitrum calcarium. Theſe, our tables ‖ teach us to ſeparate readily:

* § 238, 239. † § 121. ‡ § 118, 119, 120.
‖ § 118 to 122.

For,

For, they ſhew us, that upon throwing water on the maſs, the alcaline ſalt will firſt diſſolve, next the ſalt of the nature of Glauber's or Epſom ſalt, and laſtly, the ſea ſalt or ſal gem. But, this wants due accuracy: The beſt method is to waſh the whole maſs carefully with warm, diſtilled water, while to the taſte, or upon experiments, with ſolution of lead, ſilver, or the like, it ſhews the leſt veſtige of any ſalt. The remaneder is a matter inſoluble in water; to wit, earth; which, being carefully and effectually dried, is to be exactly weighed; and its weight being ſubſtracted from that of the whole mixed maſs, the difference tells us the quantity of groſs ſaline matter in the maſs. Then, this maſs of ſalts may be parted, as the tables * direct: The ſea ſalt will firſt cryſtalliſe; next, the Glauber's ſalt, leaving the unſaturated alcali to be evaporated to a dryneſs. Theſe ſeverally dried, their quantities or proportions are to be determined by the balance.

§ 245. Having parted the ſalts, we are next to examine and determine their kinds. The alcaline ſalt is proved, 1. by an acrid, lixivial or urinous taſte; 2. by changing blew ſirups, green, 3. by an ebullition with, and ſaturation of, all acids; conſtituting a neuter ſalt, according to the nature of the acid employed †; 4. by precipitating metallic and terrene ſolutions, made by the means of acids; 5. by precipitating a ſolution of corroſive ſublimate in an orange-colored magiſtery; 6. by inlarging or diſmiſſing the volatile alcali in ſalt ammoniac and taking its place. The marine ſalt is diſcovered, 1. by its well known taſte, not equalled by any other; 2. by the pyramido-cubical form of its cryſtals; 3. by its decrepitating, cracking and burſting into very ſmall fragments upon being thrown on burning coals or an ignited iron; each molecule betraying, by its form, from what ſtock it ſprung; 4. by pouring the ſtrong acid, called oil of vitriol upon it, whereby a violent commotion and heat is excited from

* § 210, 121. † § 176. 1. 181.

the

the ſtronger attraction between the vitriolic acid and the baſe of the ſea ſalt, the mineral alcali, than between this and its own acid; whence, the acid of ſea ſalt, being the moſt light and volatile, flies off in white fumes; 5. by its making a ſolvent for gold, aqua regia, with aqua fortis; 6. by precipitating mercury, lead and ſilver diſſolved in the acid of nitre and volatiliſing each in mercury ſublimate, ſaturnum cornuum and luna cornua. The nature of the other neuter ſalt is diſcovered, 1. by the ſize and figure of its cryſtals; 2. by its fuſibility; Glauber's and Epſom ſalt flowing with a gentle heat, vitriolate tartar, reſiſting the moſt violent; 3. Theſe kinds of ſalt are diſtinguiſhed from nitre, to which they bear the greateſt reſemblance in form, by loſing their pelucidity and crumbling into a white powder in drying; by fuſing and drying, not fulgurating or flagrating, upon being thrown on a red hot iron or coal; by mixing, without any commotion, with the ſtrongeſt acids; whereas the ſtrong acid of vitriol propels the acid of nitre in red fumes, with a violent commotion and heat; by all, but the tartar vitriolate, precipitating a white abſorbent or alcaline earth, when diſſolved in water, upon the addition of a vegetable fixed alcali to the ſolution. Moreover, 4. all theſe ſalts by fuſion with one part charcoal powder, with or without the addition of a fixed vegetable alcali, which the tartar vitriolate requires to promote its fuſion, being fluxed, yield a maſs analogous to hepar ſulphuris, which, like that diſſolves in water, and yields ſulphur in form of a magiſtery upon the addition of any acid *. Of this kind are all the neuter ſalts, hitherto diſcovered in all the waters of Europe. How different from nitre or ſalt petre, let any one conſider, who knows the remarkable effects, which attend the committing nitre, charcoal and ſalt of tartar to the fire, when they want but one of the ingredients of gun-powder, or of that compound, called pulvis fulminans, from the violence of its exploſion.

* § 196, 197, 198, 199, 200.

§ 246.

§ 246. The proportion and quality of our ſalts being thus determined; procede we next to the examination of the inſoluble, ſolid, fixed contents of our water, the terrene parts. Upon conſidering the variety of earthy particles floating in the atmoſphere, the various earths, of which our globe and its furniture are compoſed, and the great and almoſt boundleſs extent of the diſſolving faculty of water; we may be ſtaggered at the bare attempt. But, however great, and, to the ſenſes, ſeemingly endleſs, the diverſity of earths, from different modifications, may appear; yet, the real diverſity is certainly not ſo great; for, all terrene bodies, of what kingdom or claſs ſoever they be, have but one common baſe, earth, truly and properly ſo called; the ſalt, or the ſalt principle of the ancients, Terra Prima, the primary or vitrifiable earth of the modern chemiſts, in diſtinction from their Terra Secunda, the phlogiſton or inflammable principle, and from their Terra Tertia or mercurialis, the third or mercurial earth, or metalliſing principle; which, with water, are the principles or elementary particles, of which all material beings are compoſed, and conſtituted, as the chemical philoſophers * demonſtrate. However, we are not to look for mere elementary earth in our waters; but for an aggregate of groſs terrene parts; and thoſe, that have hitherto been diſcovered, fall under the general denominations of calcarious, argillaceous, or ochrous. The terrene reſiduum of water is known to be calcarious or abſorbent, 1. by its diſſolving in acids, with an ebullition; 2. by its becoming upon calcination, more white, and acrid to the taſte, inſtead of inſipid; then, by hiſſing in, and heating, water, and partly diſſolving, upon immerſion therein; in ſhort, by its putting on the character and qualities of lime. Waters, conſiderably charged with this earth, by the vitriolic acid, are of a petrifying nature. This quality is moſt evident if they be natural baths; there, we find the ſources, canals and receptacles full of

* BECHER, STAHL.

ſtoney

ſtoney concretions, as in the Caroline Baths, in thoſe of Aix la Chapelle, Borſcheit, &c. The ſediment or reſiduum of waters is known to be argillaceous, 1. when it cauſes none ebullition, and diſſolves not with acids; 2. when, inſtead of becoming whiter and more pulverulent by calcination, it puts on a darker color, and a ſtoney hardneſs. The ochrous or martial earth is diſtinguiſhed, 1. by its yellowiſh, rediſh, or brown color; 2. by its tardily diſſolving, without much commotion, in acids; 3. by its growing red by calcination, and partly anſwering the attraction of the load-ſtone; 4. by yielding fuſible iron, upon cementation or calcination, in a cloſe covered crucible, with oil or fat, particularly lin-ſeed oil.

§ 247. But, theſe are not the onely terrene bodies, we find diſſolved in water: we ſhall, in the ſequel, find another ſubſtance intimately ſuſpended in water, which, as ſoon as it puts on a concrete, though it be a ſaline form, is then nevertheleſs as inſoluble, as any earth or ſtone: I mean the ſelenite, which, upon a ſlight evaporation, immediately after the ochrous or martial earth, precipitates in pellucid fleaks, in the Pyrmont, Spa, and ſome other waters.

§ 248. Having thus layed down general rules for the examination of all waters, ſhewn how they may be impregnated, and how that impregnation may be diſcovered, I now come, according to the order propoſed,* to conſider the ſimple, ſweet, or inſipid terreſtial waters, beginning with the principal waters uſed in the oeconomy of life in and about our capital, which at preſent demands my chief attention and care.

## *Of the common waters, in general uſe, in and about London.*

§ 249. After a man has in the proper ſcholes acquired that pitch of erudition and knowledge of na-

* § 25. II. 1.

ture,

ture, which intitules him legally to the appellation of Phyſician, and really qualifies him to judge of matters in general, of man, and ſuch things as relate to his health in particular; his firſt care ſhould be to inform himſelf, as well as poſſible, of the nature and qualities of the climate, in which he purpoſes to practice, to make himſelf well acquainted with the ſoil, the air, and the water, together with their ſeveral products, whether conducive to, or deſtructive of, the life or health of mankind: Without this, no man can be preſumed capable of directing the uſe of the proper air and aliments, the avoiding noxious things, and much leſs for pointing out other means for ſupporting life, preſerving preſent, or reſtoring interrupted or loſſed health. And therefore, the phyſician, that wants this branch of natural knowledge, muſt be very defective in his profeſſion.

§ 250. Of all theſe matters, none ſeems to have leſs engaged the attention of the judicious, than the examination of waters in general; ſuch eſpecially, as are uſed for the ordinary purpoſes of life. Some regard, it is true, has been payed to the mineral waters; they have employed the pens of many. But, what degree of eſtimation authors deſerve, who take upon them to treat of compound bodies, without explaning or examining the ſimples of which they are compoſed; who pretend to analyſe a compound mineral water, without giving, or perhaps, forming to themſelves, any idea of a ſimple water, let men of common ſenſe determine. To which, by the bye, let me add, that moſt of the voluminous and numerous tracts, and of theſe the moſt pompous, we have, upon mineral waters, have been publiſhed by men living or practiſing upon the ſpot, not always competent judges of the ſubject, but always intereſted in the fame of the particular water, which was their idol, the Diana of the Epheſians; and always intereſted in letting the world know, by a book or pamphlet, calculated for the purpoſe, where the mouth of the oracle,

cle, the Prieſt of the myſteries was to be conſulted: Such a man's evidence muſt therefore be deemed as doubtful, concerning the efficacy of his favorite water, as that of any other prieſt touching the miracles of the ſhrine, by which he gets his bread.

§ 251. Before I procede to the conſideration of the mineral or medicinal waters, I ſhall firſt examine thoſe, that are immediately neceſſary to life, the ſimple waters. Of theſe, we are ſerved with greater variety and abundance, than any city in Europe can boaſt: There is not a conſiderable ſtreet in London which is not furniſhed with ſuch plenty of water, by way of aqueducts or pipes, from various ſources, beſides what its wells by pumps ſupply, that not onely the ordinary offices on the ground floor, or under it, in every houſe, but even the upper ſtory of moſt houſes are, or may be, ſupplied with water by pipes from the common aqueducts in the ſtreet. Such is the plenty of this uſeful element, that in many of the great ſtreets there is enough to ſerve the common draught cattle, and proper repoſitories are fixed to receive and keep it for theſe purpoſes. Beſides, in moſt of the broadeſt ſtreets, there are common cocks for watering the ſtreets in ſummer; from the overflowings of which, moſt places are ſupplied with water enough to ſuppreſs duſt and cool the pavements in the ſummer, and to waſh away their filth in a running ſtream through their cannals in the winter. This plenty of water prevents our having a number of hands, which may be better employed, occupied in hawking water about, as may be ſeen in Paris, and other great cities; and undoubtedly is one of the principal cauſes why our capital is the moſt healthful great city in the world.

§ 252. The ſources, whence we draw our ſupplies of water, are various, excluſive of our wells, which are very numerous and conſiderable. The firſt and great ſource is the river Thames, that great ornament and ſupport of our kingdom in general, but particularly of our metropolis. From this, water is drawn by machines,

chines in different places, as at London-Bridge, Chelſea, and at York-buildings, and conveyed by proper aqueducts to different parts of the town. The ſecond is that, called the New-River, brought in an open water-courſe from the river Lee in Hertfordſhire, to Iſlington; whence, it is conveyed by pipes to furniſh a great number of ſtreets in town. The third, is Hampſtead, where rain water, together with that of ſome ſprings, is collected and dammed up in ponds, and thence conveyed by pipes to town. The fourth, is a large ſpring, at the end of Rathbone-place, whoſe water is raiſed by a machine, now wrought by an horſe, and thrown into an open repoſitory, where it ſtands, till it is ſuffered to run by pipes to the ſeveral ſtreets in which it is uſed.

§ 253. To theſe the different wells, that furniſh the town may be added. But, as it would be endleſs to recite the extreme variety of them, I ſhall confine myſelf, for the preſent, to ſome of the moſt remarkable and moſt generally uſed of thoſe, that have, as yet, fallen under mine obſervation.

## *Of* THAMES WATER, *as it is commonly uſed in London.*

§ 254. For the trials of this water, I judged neceſſary to be made, I had it taken up, at the different times of the tide, over-againſt Somerſet-Houſe, about the middle of the river. Here, I ſhall ſet down the extremes onely of high and low water, and the experiments made upon it at theſe times of the tide, as one of the principal cauſes of the changes wrought in this water. It is alſo fit it ſhould be noted, that I made mine experiments in warm weather in May, when there had been no rain for above three weeks: Rivers, and even ſome ſprings, will be found to vary according to the quantity, as well as the quality, of the rain they receive.

§ 255. The water at low, as well as high water, was turbid, but the later moſt ſo. Upon ſtanding to

to ſubſide, it grows clear, but not perfectly colorleſs.*

§ 256. Paſſed through filtrating paper, it becomes quite clear; but, ſtill retains ſome pale ſhades of a white wine-color. The coffin of paper, through which it paſſes, being weighed before, and, upon drying, after filtration of a pint of the low water, will be found to increaſe in weight from under half a grain to upwards of a grain and even to one grain and an half; the high water increaſes to two grains and ſometimes upwards. This is the proportion of inſoluble matter, quite foregne to the nature of water, found at different times in the Thames at London; which, for all the nicer purpoſes, ſhould be ſeparated before uſing.

§ 257. In the following experiments, two ounces of the water was uſed in each; the letter L. denotes the low and the letter H. the high water compared;

§ 258. 1. Sirup of violets twenty drops, is firſt diluted onely; but, upon mixture, changes to a ſea green, which heightens ſomewhat upon ſtanding with L.

§ 259. 2. The like appearances are produced in H.

§ 260. 3. Infuſion of Campechy log-wood in diſtilled water, of a very deep yellow, or dark orange color; in L. every drop, as far as four or five, upon mixing is changed to a pink color, which, upon ſtanding, is heightened to a crimſon.

§ 261. 4. In H. a ſimilar effect is produced; but, the color paler, and inclining to a roſe purple.

§ 262. 5. A grain of cochinelle in powder thrown into L. ſtrikes a pink bloom on mixture, which, upon ſtanding, firſt heightens to a crimſon and then fades to a pale muddy purple, letting fall obſcure green clouds.

§ 263. 6. The ſame in H. produces nearly the ſame effects, the purple brighter and the clouds paler.

* Thames water at Richmond is always, in dry weather, perfectly colorleſs and pellucid. Its receding from theſe qualities muſt be owing to the foregne mixtures it receives about London.

§ 264. 7. Alcaline ley, five drops, in L. each ſhews a ſlight milky cloud, and upon mixture, it becomes milky all over. Upon ſtanding, the glaſs becomes ſlightly coated with a pale earth, whileſt an inconſiderable light ſediment is found at the bottom.

§ 265. 8. In H. the like appearances in general, ſeeming ſomewhat more milky.

§ 266. 9. A ſolution of ſoap, in L. cauſed a kind of pearl-colored milkineſs; but, no coagulation; for, next day, the mixture appeared pretty ſmooth and uniform.

§ 267. 10. In H. the like appearances as in L. at firſt; but next day, ſome grumous coagulations were found.

§ 268. 11. The diluted acid of vitriol works no perceptible change in either L. or H. and conſequently none other, of inferior ſtrength, works any.

§ 269. 12. A ſolution of quickſilver in the acid of ſea ſalt, that is, mercury ſublimate, diſſolved in a ſufficient quantity of pure water, this, as far as ten drops, wrought no ſenſible change on mixture with L. Upon ſtanding, a mother of pearl-colored pellicle covered the ſurface, leaving the liquor underneath ſlightly milky.

§ 270. 13. In H. much the ſame effects were wrought; the pellicle was paler, and ſome very light grumous precipitate appeared.

§ 271. 14. A ſolution of mercury in the acid of nitre; This produced pale clouds at every drop, which appeared at firſt milky and white, but ſoon changed to a yellowiſh color. I added four drops; being mixed, the liquor got the ſame color all over. Upon ſtanding, a ſlight, pale pellicle aroſe and a muddy ochre-colored ſediment ſubſided.

§ 272. 15. In H. the like effects were ſhewn, with a ſomewhat larger precipitation.

§ 273. 16. A ſolution of lead in diſtilled vinegar; of this every drop, as far as four or more, cauſed a bright milky cloud; which, growing more opac and white,

white, ſubſided. At four, being ſtirred, it had a milky opacity all over. Upon ſtanding, it threw up a broken, pale pellicle, and let fall a ſlight, white precipitate.

§ 274. 17. With the H. the difference of effects were not ſenſible.

§ 275. 18. A ſolution of ſilver in the acid of nitre, to four drops, in L. cauſed a pearl-colored milkineſs firſt in clouds; upon ſtirring, all over. Upon ſtanding, this ſubſided, covering the bottom and ſides of the glaſs with a fair, violet purple precipitate.

§ 276. 19. In H. it produced ſimilar effects, the precipitate inclining more to the roſe, than the violet, yet partaking of the color of each.

§ 277. By what has been ſayed, in the general idea of ſalts and the method of examining waters, it is eaſy to conceive the cauſes of theſe changes, or rather to what mixture in the waters, they are to be imputed. From Exp. 1. 2. an alcaline principle in a ſmall quantity is aparent in Thames water at London; leſs at high, than low, water; beſides, at that time, ſome particles more of ſea ſalt mix with it, than can be in it when the tide is out. 3, 4; 5, 6; ſhew a calcarious earth diſſolved in the marine acid, with perhaps ſomething of the volatile alcali; whence it appears an unfit water for the ſcarlet dye. 7, 8. ſhew both charged with terrene parts, which muſt have been diſſolved by means of an acid; of which the H. ſeems to contain more than the L. by its giving more precipitate with the ſame quantity of alcali. This notion ſeems confirmed by 9, 10. in the former of which, the ſoap unites with the water; whileſt in the later, it is partly decompoſed. 11. ſhews, an alcali is not predominant in either. By 12, 13. it appears, the quantity of alcaline matter is moſt inconſiderable. By 14, 15, that ſome abſorbent earth, by the means of an acid, is ſuſpended in the water; of the later of which more appears in H. than in L. water, by the later

experiment. This acid appears to be the univerſal, from the color of the precipitate; which, were it the acid of ſalt, ſhould be a pure white. This terrene impregnation is ſhewn above, 7, 8; 9, 10. In further proof of theſe, come 16, 17. As 18, 19 do, to demonſtrate ſome portion of a muriatic ſalt, of which there appears moſt in H.

§ 278. To give farther proofs of theſe trials, and to determine the proportions and natures of the ſolid contents in this water, evaporated, after having firſt filtrated it, at different times of the tide. I ſhall here onely recite the extremes: I took a gallon of the Thames at low water from the former place, ſet it in a clean glaſs bell or pan placed in ſand, in a ſand furnace. I gave fire gradually, till a vapor aroſe; and kept it in that degree of heat, raiſing it out of the ſand, as the humidity exhaled, till the whole was conſumed. In the proceſs, I obſerved, 1. as it heated, it threw off ſome air in bubbles to the ſides of the glaſs and ſurface; but not ſo much, as moſt of our ſprings and pumps; 2. It grew ſomewhat milky; 3. It threw up a terrene pellicle; 4. During this time, no remarkable ſmell could be perceived from it; 5. The liquor, which was not at firſt perfectly colorleſs, as the humidity exhaled, the remaning part appeared more colored, even to that of white wine, and ſtill deeper towards the end; 6. As it conſumed, it left ſome light, pale earth along on the ſides of the glaſs, looſely adherent; 7. When it was reduced to about three or four ounces, it began to coat the glaſs round its ſurface with a thick, brown, ſeeming greaſy cruſt; this continued for about half an inch, but, 8. below it, nothing remaned, upon completing the evaporation, but a thin coating of coarſer, ſandlike earth, ſlightly, if at all, adherent. 9. Expoſed to the open air, at the lower part eſpecially, it contracted ſome humidity, and grew ſoft and pultaceous. 10. The glaſs ſet again in warm ſand, it readily dried as before; being carefully gathered and mixed, it appeared of a

dark

dark olive or lute color, and weighed fiveteen grains. It felt gritty or ſandy between the teeth, and taſted ſlightly bitteriſh, acrid and ſaline.

§ 279. One gallon of Thames, at high water, exhibited the like appearances and products, upon the ſame treatment; but, a greater quantity of ſolid contents: For, the reſiduum dried with equal care weighed ſixteen grains and an half, which taſted evidently more ſalt, than the preceding.

§ 280. Thus it appears, that every pint of purified Thames water, at London, contains, in the one extreme leſs in the other more, about two grains of ſolid matter, which now remanes to be examined.

§ 281. 1. This matter, with the ſtrong acid of vitriol, cauſed a ſtrong ebullition and ſome degree of efferveſcence; and emitted ſome fumes, with all the ſenſible appearances of the acid of ſea ſalt.

§ 282. 2. In the diluted acid of vitriol, a very ſenſible ſtrong ebullition, which continued long, without a complete ſolution.

§ 283. 3. Ten grains of the dry matter, waſhed with an ounce of pure water, gave it the tincture of mountane wine, and left in the filtrating paper ſix grains of inſoluble, conſequently terrene, matter, of an aſh color.

§ 284. 4. The waſhings of this, 1. grow milky with alcohol: 2. work no very remarkable change in ſirup of violets; 3. are not ſenſibly affected by acids; unleſs the vitriolic, which in large quantities, expels the fumes of the ſalt, with a great efferveſcence, and forms a ſelenite; 4. mix with alcaline leys without any commotion; but ſuffer a conſiderable precipitation, which is of the nature of magneſia alba; 5. precipitate a ſolution of quickſilver, not perfectly white; 6. that of ſilver, into luna cornua; 7. evaporated, they leave the glaſs coated in pale yellow rings, which, ſcraped off, give about three grains in weight, of a ſaline and oleoſe taſte, which grows moiſt in the air; 8. rectified ſpirit of wine poured on it and digeſted, diſſolved and carried off the coloring matter,

leaving the ſaline behind; 9. Theſe diſſolved in water gave cryſtals and every other proof of ſea ſalt, weighing near two grains; but, could not be kept long dry; 10. The tincture had an higher aromatic ſmell and taſte than the ſpirit; 11. It grew milky upon mixture with acids; but, without any ebullition; 12. It did the ſame with pure water.

§ 285. 5. Ten grains of the firſt reſiduum thrown into a ſmall, well ignited crucible, it fumes and flames, and gives a ſmell, ſuch as if oil or greaſe were burning, without any ſenſible acid vapor or blewneſs in the flame. It then becomes black. Upon urging the fire, till it is ignited all over, it ceaſes to fume; does not fuſe; changes color to a pale aſh color; loſes ſomewhat better than four grains of its weight, and gets ſomething of an alcaline or acrid taſte.

§ 286. 6. The waſhings of this calx, 1. taſte like lime water preciſely, and like that throw up a pellicle on ſtanding; 2. turns firſt to a bright and then to an obſcure green with ſirup of violets; 3. becomes milky and lets fall a fine white precipitate with volatile and fixed alcalies; 4. mixes without commotion with diluted acids; and gives every other known proof of being a perfect lime water.

§ 287. From § 281. 1. and § 282. 2. It appears, that theſe mixed ſolid contents of our water contain, an abſorbent earth and ſea ſalt. § 283. 3. and § 285. 5. ſhew the terrene parts to be ſix grains in ten. § 284. 4. proves the coloring, which is probably an oily, matter, together with the ſaline, diſſolved in the water, to be four grains in ten. § 284. 4. N°. 6. demonſtrates about three of theſe four grains to be ſea ſalt, with a ſuperabundance of its acid and ſome earth, whence it is apt in part to deliqueſce; the reſt an oily matter. And § 285. 5. and § 286. 6. prove the earth to be calcarious. Of the ſaline or ſoluble parts, more in the ſequel.

§ 288. Theſe are the conſtituent parts of Thames water and their proportions at low water, in London.

The

The onely difference obſervable in the high, is a little more ſalt.

§ 289. Many have ſought, and ſome ſpoke of, a ſpirit to be extracted from Thames water. It is found liable to ferment and putrify. This may happen from the oily matter and others in the water; yet, it chiefly happens when it has layen ſometime in wooden veſſels. What it then affords by diſtillation is by no means to be imputed to the water alone; it partly belongs to the extractive parts of the wood, which the water diſſolves, ſubtiliſed by fermentation or putrefaction. But, from the component parts of the water, and from the immenſe variety of mixtures, it receives from the city, it will not be wondered, if it ſhould be more apt than ordinary to ferment and putrify. The products of fermentation and putrefaction are not to be attributed to the water; both of theſe are but creatures of theſe operations, and conſequently, foregne to the water, in the natural ſtate; in which alone it falls under our cogniſance here.

§ 290. This is found one of the lighteſt, pureſt, ſofteſt and beſt river waters, into which the tide flows. The quantity of matters, foregne to pure water, contained in it, is very inconſiderable; notwithſtanding the immenſe quantity it daily appears to receive. It is not eaſy to collect rain water with much leſs; eſpecially near a great city. And though the proportions may be found to vary, yet theſe ſame principles or rather mixtures are to be found in ſome degree in moſt waters, that touch the earth.

§ 291. Such ſuperficial naturaliſts, as enter upon the examination of ſome one or more medicinal waters, without having ever enquired into the nature of ſimple water, or compared the one with the other, are apt to aſcribe the virtues of their favorite water, which, with many, may be conſidered as their idol, to ſome one or more of the ingredients, now demonſtrated in the Thames, and to be found, in ſome degree, in all waters, ſimple as well as medicated. Upon looking into

any of our modern thermal phyſicians, it will readily appear, that they aſcribe ſulphur and bitumen, and even give the epithets, ſulphureous or bituminous, to certain waters, for no better reaſon, than an oily ſubſtance appearing in their reſidua, as here. The ſenſible will aſſuredly beware of confiding in ſuch waters, as ſulphureous; when all he meets, whether hot or cold, are generally ſuch, in ſome meaſure. And who ſhould truſt the phyſician, who relies on any water for ſulphureous qualities, which are found as plenty in ſprings, rivers, lakes and ponds, as in his boaſted Bath?

## *Of the* NEW RIVER WATER.

§ 292. Next in order, as in importance in the oeconomy of life, to this metropolis, is the great ſource of water, with which our city is ſupplied by an aqueduct from Hertford-ſhire; I mean the New River, whoſe water is conveyed from the reſervoirs at Iſlington to many different parts of our capital. This water bears great analogy to that of the Thames at low water, as appears by the following experiments.

§ 293. 1. It is nearly the ſame in pellucidity and color, at the taking up from its courſe, and when fined by ſubſidence or filtration; in the later, it leaves much the ſame quantity of foulneſs.

§ 294. 2. It gives a paler green with ſirup of violets.

§ 295. 3. It gives a paler pink color, with Campechy wood; but, heightens in the ſame manner and degree with Thames at low water.

§ 296. 4. With cochinelle, it produces the like appearances, as that.

§ 247. 5. The ſame effects are alſo produced in both, with fixed alcalies, concrete and liquid; but, in a ſlighter degree; for, this becomes leſs milky and ſhews leſs ſediment.

§ 298. 6. With a ſolution of ſoap, it becomes leſs milky, and upon ſtanding ſhews no coagulation or ſeparation.

§ 299.

§ 299. 7. It ſuffers no ſenſible change with acids.

§ 300. 8. With a ſolution of corroſive ſublimate, it ſuffers no viſible change at mixture; upon ſtanding, it throws up a diverſicolored pellicle, in which orange appeared to predominate. There was no perceptible milkineſs nor other alteration, but many ſmall air bubbles about the glaſs.

§ 301. 9. With the ſolution of mercury, it produced much the ſame appearances, as L. with rather a ſlighter precipitation.

§ 302. 10. With the ſolution of lead, all the ſame appearances, but in a lower degree, were produced.

§ 303. 11. With the ſolution of ſilver, it wrought the like effects; but ſlighter; and with the precipitate of a pale violet color.

§ 304. As this water is found to bear ſuch analogy to that of the Thames at low water, as to point out a compariſon; the reaſon for the effects of theſe trials are to be ſought under the former head.

§ 305. I committed this water to evaporate in the ſame manner, as that of the Thames was before treated. I found it yielded all the ſame appearance, but in a lower degree; except air, which ſeemed in this more abundant. The reſiduum was of a pale color. And a gallon yielded but fourteen grains. This ſeemed alſo leſs ſalt to taſte.

§ 306. 1. This matter in the ſtrong and diluted acid of vitriol gave the ſame appearances and produced the ſame effects as in § 281. 1. § 282. 2.

§ 307. 2. Ten grains of it gave not ſo ſtrong a tincture as in § 283. 3. Left in the filtrating paper, of terrene matter of a paler color than before waſhing, above ſeven grains.

§ 308. 3. The waſhings, 1. deſtroy the color of ſirup of violets, and then give a pale ſea green upon ſtanding; 2. become milky with alcaline ley and with alcohol; 3. are not ſenſibly affected by diluted acids; 4. cauſe a milkineſs and precipitation with a ſolution of quick-

ſilver,

ſilver, leſs colored than that in § 284. 4. 3. and the like precipitatation of luna cornua, in a ſolution of ſilver, rather paler, but upon ſtanding, partly of a ſlate color; 5. They give all the other effects of numbers 6, 7, 8, 9, 10, 11. with leſs of the coloring matter and rather more of the ſalt.

§ 309. 4. Ten grains of the dried reſiduum, thrown into an ignited crucible, fumed and flamed; but more ſlightly and ſhortly than that of Thames water. Calcined like that, it did not fuſe; loſſed ſomewhat better than three grains of its weight; changed to a paler aſh-color; and to an abſorbent and lime-like taſte, rather ſlighter, than that of Thames water; § 285. 3.

§ 310. 5. The waſhings of this calx ſtood every teſt of lime water, as well as that of § 286. 6.

§ 311. From theſe experiments and obſervations, it appears in what manner and proportion this water differs from or agrees with the Thames water. The reaſons are ſo obvious, from what has before been ſayed, that pointing them out would be but teadious and unneceſſary repetitions to the intelligent and attentive, by whom alone I can hope to be underſtood.

§ 312. Theſe waters may with ſafety and propriety be uſed, wherever a pure ſoft water is requiſite, for drinking or bathing; for waſhing or bleaching; for dreſſing of food, animal and vegetable; in the ways of baking or boiling; for making malt and for brewing; for preparing medicines by infuſion, decoction, diſtillation, &c. But, for the exact dilution of ſolutions for precipitations; for the waſhing of magiſteries; for dying the tenderer colors; for the accurate cryſtalliſation of ſalts, and the like operations, purer waters ſhould be ſought by the curious operator.

## *Of* HAMPSTEAD WATER.

§ 313. 1. This is partly the product of ſprings and partly rain water collected in ponds about the hills of Hamp-

Hampſtead and Highgate, about four miles from London, and conveyed by pipes, through Kentiſh-town, to certain parts of the town.

§ 143. 2. It is ſeldom quite bright to the eye, till it ſtands ſome time to ſubſide. After rain, it is very apt to be turbid, from the quantity of light clay, waſhed into it from the hills and high ways.

§ 315. 3. Set ſtanding in a glaſs for twenty-four hours, it 1. diſcharges ſome air, in ſmall bubbles, which fly off partly at the ſurface and partly ſtick to the ſides of the veſſel; 2. It lets ſome light ſediment fall, and grows proportionably clearer.

§ 316. 4. The color of ſirup of violets is firſt diluted, then changes to a ſea green, which upon ſtanding heightens. In twelve hours, it becomes yellowiſh.

§ 317. 5. The infuſion of Campechy log-wood gives a pink bloom; upon ſtanding, a little while, heightens ſomewhat; afterwards begins to fade, till in ſome hours it comes to the color of old Canary wine.

§ 318. 6. With cochinelle it gives a very beautiful crimſon, which heightens upon ſtanding, and in twelve hours ſuffers no diminution of color.

§ 319. 7. Alcaline ſalts, concrete and liquid, in double the proportion added to Thames water, work hardly any ſenſible change, upon mixing or ſtanding in this water.

§ 320. 8. The ſolution of ſoap mixes ſmoothly and cauſes a ſlight lacteſcence; but, none other ſenſible change.

§ 321. 9. With the ſlighter vegetable acids, as diſtilled vinegar, it ſuffers no change. With the diluted vitriolic acid, it mixes without any ſenſible commotion; upon ſtanding ſhews ſome air bubbles and ſeems ſomewhat brighter.

§ 322. 10. With the ſolution of mercury ſublimate, upon dropping, no change appears; upon ſtanding it ſeems lacteſcent, and throws up a ſlight, pale, mother-of-pearl-colored pellicle, but ſhews none air. In about

twelve hours, it appeared covered with a ſmooth variegated pellicle; ſhewed no ſediment; but, the glaſs was ſlightly coated.

§ 323. 11. Every drop of the ſolution of mercury cauſed a white milky cloud, which ſoon turned to a pale yellow. This upon ſtanding, precipitated fairly; whileſt a ſlight pellicle of different colors aroſe upon the ſurface.

§ 324. 12. The ſolution of lead cauſed at every drop a pale milkineſs, which, at four, heightened to a pearl-color, without any viſible ſeparation. In twelve hours a pale, ſlight and broken pellicle appeared on the ſurface and an inconſiderable pale precipitate ſubſided.

§ 325. 13. Every drop, as far as four, of the ſolution of ſilver cauſed pale, blewiſh white clouds, which upon ſtirring rendered it all over of a pearl-color. In twelve hours, a blewiſh ſlate colored precipitate thinly covered the ſides and bottom of the glaſs.

§ 326. 14. A gallon of the purified water evaporated in a glaſs bell in a ſand heat, 1. ſhews a good deal of air, which partly ſticks in bubbles to the ſides of the glaſs, and partly flies off, as the water warms; until, 2. a pellicle ariſing upon the ſurface arreſts ſome of them and forms large bubbles, which cover the whole. 3. In the operation, the vapor, that flies off, has an earthy ſmell. 4. As the water exhales, the pellicle coats the ſides of the glaſs, grows higher colored and thicker towards the bottom; where, 5. it makes a circular cruſt of a darker color, in the center of which, 6. A light, thin, paler cruſt appears. 7. Theſe, well dried and collected with all care and caution, weighed four ſcruples and ten grains; 8. Gave a terrene taſte with ſome ſaline acrimony; 9. abſorbed humidity enough from the air to increaſe their weight, in wet weather.

§ 327. Hence it appears, that every pint of Hampſtead water contains eleven grains and a quarter of ſolid matter, which we now procede to examine.

§ 328.

§ 328. 1. This reſiduum, with the ſtrong acid of vitriol, cauſed a ſtrong ebullition with ſome degree of efferveſcence and ſome ſharp, white fumes like thoſe of ſea ſalt, to all ſenſible appearances.

§ 329. 2. In the diluted acid, it cauſed a ſtrong and long commotion; but, was not completely diſſolved.

§ 330. 3. Ten grains of it waſhed with an ounce of pure water and filtrated gave it the tincture of mountane wine, and left in the filtrating paper five grains of a paler, a kind of creme-colored earth.

§ 331. 4. The waſhings at firſt but diluted the color of ſirup of violets, then diſcharged it, and upon ſtanding put on ſome ſhades of a ſea green; 2. cauſed no commotion with acids; 3. with alcaline ley, no commotion, but a milky opacity, and with alcohol, a milkineſs; 4. precipitates the ſolution of quickſilver yellow, and 5. that of ſilver grumous and white; 6. evaporated to a dryneſs it affords phaenomena ſimilar to thoſe of this part of Thames water, § 284. 4. N°. 7, 8, 9, 10, 11. the ſaline reſiduum more apt to run liquid in the air.

§ 332. 5. Ten grains of the firſt reſiduum thrown into an ignited crucible gave but little fumes, of the ſmell of burning bricks; but no flame; ſoon after fuſed and bubbled ſmartly, then ſubſided and run ſmooth, and in about a minute fixed. It loſſed of its weight, in this operation, three grains and an half; and put on the aſpect of a fuſed ſalt, the taſte of which, with ſome lime-like acrimony, it had acquired.

§ 333. 6. The waſhings of this 1. had a ſalt taſte, with ſomething lime-like or lixivial; 2. mixed with acids without any ſenſible commotion; 3. was precipated by alcalies and gave every proof of being a lime water.

§ 334. To offer a compariſon betwixt this and the preceding waters, would be but teadious and unneceſſary; and the etiology of the experiments, would be but a diſagreeable repetition; as the cauſes of the changes,

changes, the difference between this and the other waters, and which deſerves the preference in particular uſes, muſt readily occur to the attentive, who alone can profit by theſe or ſuch like analyſes.

## *Of* RATHBONE-PLACE WATER.

§ 335. 1. This water does not appear perfectly bright to the eye; ſet in a glaſs for ſome hours, it lets fall a ſlight earthy depoſite, and throws up a terrene pellicle upon ſtanding; whileſt it covers the ſides of the glaſs with air bubbles.

§ 336. 2. Sirup of violets has its color firſt diluted, then turns greeniſh, and improves but little by ſtanding.

§ 337. 3. The infuſion of Campechy wood gives a kind of Madeira wine color, which heightens a little upon ſtanding.

§ 338. 4. Cochinelle gives a roſe purple, which holds for ſome time; but, in about twelve hours, ſhews ſome greeniſh clouds precipitating.

§ 339. 5. The ſmalleſt portions of alcaline ſalts, in a liquid or concrete form, cauſe a milky opacity, the later a greater ebullition than ordinary, and upon ſtanding, precipitate a conſiderable quantity of pure, white earth, and throw up a terrene pellicle to the ſurface.

§ 340. 6. Every drop of the ſolution of ſoap coagulates on the ſurface, and being mixed, inſtantly ſuffers a complete decompoſition.

§ 341. 7. With acids, it ſuffers a very ſenſible commotion, throwing off much air in minute bubbles to the ſurface and to the ſides of the glaſs, and becoming more pellucid.

§ 342. 8. The ſolution of corroſive ſublimate, cauſes a conſiderable milky opacity upon dropping, firſt at the bottom of the glaſs, and upon ſtirring, it appears of a pearl colored milkineſs all over. It throws up a diverſicolored pellicle, and in about twelve hours, lets fall a fair, pale precipitate.

§ 343.

§ 343. 9. The ſolution of quickſilver cauſes the ſame appearances, as in Hampſtead water, the clouds more opac, their upper ſurface more white, the precipitation ſooner formed of a deeper color, with a ſtrong, variegated pellicle.

§ 344. 10. Every drop, as far as four, of the ſolution of lead in diſtilled vinegar, cauſed a thick white, milky, opac cloud, which ſuddenly precipated. In twelve hours, the precipitation was complete, of a kind of creme color, and a ſlight pellicle formed on the ſurface.

§ 345. 11. A ſolution of lead in the acid of nitre, which cauſed no ſenſible change in the Thames at high or low water, in the new river water and that of Convent-garden pump, at firſt ſuffered none alteration in this. But, ſoon after ſtirring, it began, upon ſtanding, to coat the glaſs, and in twelve hours, ſhewed a very white precipitate. This the Savoy pump produced more ſuddenly.

§ 346. 12. Every drop of the ſolution of ſilver cauſed opac white clouds at dropping. Upon ſtirring, the mixture appeared of a milky opacity all over; and upon ſtanding, let fall a pale, ſlate colored precipitate in greater plenty, than Hampſtead water did.

§ 347. 13. A gallon of this water committed as the others to evaporation in a ſand heat, as it heated threw off a great quantity of air, which roſe in ſmall bubbles from all the firſt and moſt warmed parts of the glaſs to the cooler parts and to the ſurface of the liquor. As this eſcaped, a pellicle aroſe on the water, which thickened, as the air and humidity diminiſhed, ſo as to be at length able to retain much of the air in great bubbles at the ſurface. The vapor had no remarkable ſmell. The pellicle did not coat the glaſs, ſo thickly or firmly, as that of the Hampſtead water; and the ſolid contents coaleſced in grumes or a kind of roundiſh granules at the bottom, of a pale lute color. Theſe, ſcraped carefully off and well dried, weighed five ſcruples of a more piqnant ſaline taſte, than thoſe

of

of Hampſtead; like which they ſeemed to grow moiſt upon being expoſed to the air.

§ 348. This ſhews, that every pint of the water of Rathbone-place contains twelve grains and an half of ſolid matter.

§ 349. 1. This reſiduum with the ſtrong and dilute acid of vitriol gave the ſame phaenomena with that of Hampſtead waters.

§ 350. 2. Waſhed in the like proportions with pure water, it gave the like tincture, leaving about four grains of a paler earth in the paper through which it was filtrated.

§ 351. 3. Theſe waſhings, more than any of the preceding, tended 1. to change ſirup of violets to a pale green; yet, 2. cauſed no commotion on mixture with acids; 3. with alcaline ley, a milkineſs and precipitation; 4. with alcohol, a great milkineſs; and anſwered all the other experiments made upon the like reſidua of the preceding waters.

§ 352. 4. Ten grains of the firſt reſiduum projected into an ignited crucible fumed and ſmelled the leſt of any, ſooneſt fuſed, bubbled, ſubſided and fixed; loſſed barely three grains of its weight; gave not ſo ſtrong a ſenſe of ſaltneſs or acrimony upon the tongue, as any of the preceding; being more compact and inſoluble. However, its waſhings anſwered all the preceding characteriſtics of lime water; but, was not ſo ſtrongly charged with the lime.

§ 353. The changes with acids, § 341. 7. and the decompoſition of the ſolution of corroſive ſublimate, § 342. 8. diſtinguiſh this from the preceding waters; the cauſe of which is evidently an alcali, as appears by § 351. 3. but, more probably of the volatile kind, ſince N° 2. ſhews it remanes not after evaporation, at leſt in a quantity ſufficient to cauſe a new commotion with acids.

§ 354. It may ſeem a paradox, that this water ſhould at once give proofs of its containing an acid and an alcali: The difficulty will be cleared up, when it is conſidered, that the acid in this and many other

ſuch

ſuch like waters is of a volatile nature, and flies off, not onely upon the fire, but in the open air, as is proved by this water's growing ſoft and depoſiting the earth, with which it is charged, by the means of this acid, upon ſtanding in the open air. Of this effect, the proprietors of the works are appriſed; for, they let the water ſtand in a large open baſon before it is taken in by any body for common uſe. After it has thus ſtood, it proves a very uſeful, good water for the ordinary purpoſes of families. But, of this acid and this alcali, a clearer notion ſhall be given in the introduction to the ſecond part of this eſſay.

§ 354. To the water of Rathbone-place works, all the pump-waters, as well as the ſprings, I have yet met with in London and Weſtminſter, bear ſo great analogy, that I can onely find them charged all with the ſame ingredients, but in proportions ſomewhat different. Thus, for inſtance, the public pumps at ALDGATE, in ST. PAUL'S church-yard, in HARE-COURT, in the Temple, in SWAN-YARD, in the Strand, in the SAVOY, in CONVENT-GARDEN Market, at the BANQUETTING-HOUSE, Whitehall, and ST. MARGARET'S church-yard, Weſtminſter, as well as the ſprings of LAMB'S CONDUIT, CROWDER'S well, and POSTERN-ROWE, ſhew none eſſential difference upon any trial. The variations, that are diſcovered, ariſe chiefly from the different proportions, not eſſences, of the compoſition. It would be but tedious here to enter into particulars. I ſhall therefore confine myſelf to ſome of the moſt remarkable, which may excite men of more parts and leiſure to purſue the uſeful enquiry upon the plan here layed down.

§ 355. 1. ST. PAUL'S church-yard-pump, upon evaporation, gives a ſtraw-colored matter, ſixty-one grains to the gallon; that is, ſeven grains and an half and one eighth of a grain to a pint; which matter, 1. abſorbs the humidity of the air, 2. produces analogous effects, with ſtrong and diluted acids, with the preceding.

§ 356. 2. This matter waſhed with pure water, as the preceding reſidua, gave the like tincture, paler; and being filtrated left but three grains of terrene matter, of a paler color than before waſhing, in the coffin.

§ 357. 3. The waſhings produced the like effects with thoſe of Rathbone-place.

§. 358. 4. The firſt matter thrown into an ignited crucible gave the ſame appearances with the reſiduum of that alſo.

§ 359. The SAVOY pump treated in like manner, gave the like products, ſix grains leſs in a gallon; but, this was more ſaline; for, in waſhing, it left but two grains and an half of earth. The reſt being a kind of ſalt. The waſhings were of a pale color; and wrought all the effects of the preceding, fumed, rather leſs; fluxed ſomewhat ſooner, bubbled, ſubſided and gave lime, like the reſt.

§ 360. CROWDER's well evaporated with appearances ſimilar to the pump-waters; but, its reſiduum was more colorleſs than moſt; for, upon the glaſs, it looked more like a ſaline cruſt, than an earthy matter; and being left quite dry upon the glaſs at night, by the next morning, it had abſorbed humidity enough, to appear in large yellow drops upon the ſides of the glaſs, of a very acrid and ſeeming alcaline and lixivial taſte. The ſand being again heated, till it was perfectly dry, the reſiduum, whileſt hot ſcraped carefully off and gathered, weighed four ſcruples from a gallon, that is, ten grains from a pint, and now appeared of a pale olive color of a very ſharp acrid taſte.

§ 361. Ten grains of this, waſhed like the others, 1. gave the ſame kind of tincture. 2. Theſe waſhings gave a tendency to a ſea, and then to a pale green with ſirup of violets; yet, 3. mixed without commotion with acids; 4. was precipitated by alcaline leys, and in ſhort, produced effects analogous to the other waſhings of the preceding reſidua.

§ 362. What remaned in the filtrating coffin, dried, weighed four grains, and became of a pale aſh-color. So that ſix grains of the ten are ſalt, of the ſame nature with the reſt.

§ 363. Projected into an ignited crucible, the firſt reſiduum fumed very little, fuſed, bubbled, ſubſided and gave lime, like the reſt.

§ 364. LAMB'S CONDUIT ſhewed leſs air in evaporating, having been two days drawn, the ſpring being then dry. 1. It gave twenty grains and an half of matter darker colored than any of the reſt, of much the ſame taſte with that of Crowder's well; but ſeemingly more earthy, in that, that it did not run ſo much, or ſo much attract the humidity of the air; 2. it was like the reſt affected with the acids; 3. waſhed like them, it gave an high old Canary wine-colored tincture, which produced the like effects with the other waſhings in general, making allowance for the difference of color; 4. Thoſe left in the paper, through which they were waſhed, above four grains and an half of a much paler earth; ſo that not above five grains, and about a quarter, in ten, were ſalt of the ſame nature with the reſt. 5. The firſt reſiduum projected into an ignited crucible exhibited ſimilar appearances and effects with the others, but fuſed rather more ſlowly.

§ 365. As the ſalt-like ſubſtances, extracted by elixiviation of the reſidua of theſe waters upon evaporation, are not ſufficiently explaned by any one, I have yet met with, it is proper to ſpend ſome time and pains in examining them a little further.

§ 366. The reſiduum of every one of theſe waters, that of rain and of every other water, I know, that does not contain ſome other neuter ſalt, than that of the ſea, abſorbs the humidity of the air in ſome degree, and humects or runs liquid in ſome meaſure, like thoſe, that contain the nitre of the antients or mineral alcali, or rather more.

§ 367. This deliqueſcence or ſolution always has an acrid taſte, as the reſiduum itſelf imprints upon the tongue. From its ſolubility, as well as taſte, one is naturally induced to conclude this a ſalt, and from its abſorbing the humidity of the air, one is prompted, at firſt ſight, to pronounce it, an alcali, as KUNCKEL has, from the like properties, miſtaken the ley or bittern of ſalt water. But, we muſt be cautious in our concluſions. It will be found, that the waſhings of theſe reſidua give ſome portion of ſalt; but, all that diſſolves is not to be looked upon as a ſalt, ſtrictly ſpeaking. When the oily parts are ſeparated by alcohol, or by calcination of the maſs left upon evaporation of theſe waſhings, it then readily diſſolves in water, or by reſorbing the humidity of the air. Then, by evaporation, it will ſhew ſome cryſtals of ſea ſalt; but a great part remanes, that will not cryſtalliſe. If the ſolution be evaporated to a dryneſs, it will not long hold a concrete form; but, will attract moiſture and again run liquid. This, muſt be confeſſed to be one of the characterſtics of an alcali; but, the others muſt concur before any concluſion is drawn. Theſe-like leys or ſolutions of fixed alcalies, 1. inſtantly tinge ſirup of violets of a bright green; 2. cauſe an ebullition with, and ſaturation of, acids. But, our ſolution, or theſe waſhings of the reſidua of our waters, 1. hardly change the color of ſirup of violets; 2. cauſe none ebullition with, or ſaturation of, acids: but, with the heavier, as the vitriolic acid, produces a ſelenite, after expelling the marine acid, in perceptible white, ſharp fumes; and, inſtead of mixing without any ſenſible change, as one pure alcali does with another, every alcaline ſalt, whether fixed or volatile, cauſes a fair precipitation in theſe waſhings of our reſidua, of an abſorbent earth, in all reſpects correſponding with that called magneſia alba; and being added, till no further precipitation is cauſed, produces, with fixed alcalies, a purer ſea ſalt, one with a vegetable, inſtead of a mineral

neral alcali to its baſe; and with volatile alcalies, ſal ammoniac. Though then it appears, that our reſidua may contain ſome inconſiderable quantity of ſea ſalt; we may be aſſured, the far greater part is Mater Salis, the mother of ſalt, bittern, well known to our workers in ſalt, whether of the ſea or of our mediterranean ſalt ſprings, which is the acid of ſea ſalt, charged with calcarious earth, inſtead of the mineral alcali; and is therefore a liquor analogous to HOFFMAN's Lixivium Salis and to the Oleum Calcis of the chemiſts, or the liquid ſhell of ſome of our quacks, which is the acid of ſea ſalt, charged with lime, ſhells of fiſhes, or other calcarious earths. Theſe will be found upon every trial to produce analogous effects; ſuch as not keeping a concrete form; ſlightly changing the color of ſirup of violets; mixing without commotion with the light, and giving a ſelenite with the heavier acids; precipitating with fixed and volatile alcalies, &c. &c. &c.

§ 368. The curious, if there be any ſuch, who read this, will probably enquire, whence the origine of this, as well as other parts of the compoſition of our river and ſpring waters?—Whence the waters themſelves, is already made obvious. How they may be differently impregnated with various bodies, has, in our general idea of ſalts, as well as in examining the properties of water in particular, been layed down. The onely difficulty, I apprehend here remaning to be cleared up, is the ſeeming change of the nature of the acid, by whoſe means the water becomes impregnated. The ebullition ariſing upon the dropping the acid of vitriol or others into any of thoſe waters, that of Rathbone-place in particular, might have partly aroſe upon the propulſion of the lighter mineral, natural acid, or the ethereal and elaſtic ſpirit, by the union of the heavier, arteficial acid to the terrene parts, which were by the former at firſt held in a ſtate of ſolution in the water; as well as it might alſo from ſome alcaline principle. This alcaline principle muſt

be of a volatile nature, ſince it is not to be diſcovered in the reſiduum after evaporation. To this the milkineſs and precipitation, with ſolution of ſublimate, may be attributed. That ſuch an alcali is found in the earth, BERGER, HOFFMAN, WALLERIUS, &c. are agreed, as ſhall be ſhewn in the ſequel. This native acid, by which the earth in theſe waters appears diſſolved, is moſt probably of a vitriolic nature, the univerſal acid; as may be judged from its precipitating a ſolution of mercury in the acid of nitre, yellow; as every ſolution of a calcarious earth in the vitriolic acid does; whereas a white precipitation is produced with that mineral thus diſſolved, and a ſolution of theſe earths in the acid of ſalt. The acid of ſalt is judged to be produced by the union of the third earth or mercurial principle with the vitriolic acid. Both the one and the other are plentifully diſperſed throughout the creation. We need not then wonder at it in this water; nor that the acid of ſea ſalt united to this earth may appear after the volatile vitriolic acid, or ſubtil mineral ſpirit of the waters, has been exhaled: For, that this is evidently the marine acid, no doubt can remane from the preceding experiments.

§ 369. By whatſoever means waters become impregnated with earths of any kind, they come under the denomination of hard waters, will be precipitated by alcalies, and decompoſe ſoap. The waters, in which theſe effects have appeared, are of this claſs. But, this containing the marine acid, is leſs liable to produce the evil effects, which attend thoſe of the vitriolic ſolutions of ſuch earths, which give that inſoluble ſubſtance, called a ſelenite, which obſtructs and fouls the glands, and poſſibly contributes to the generating of ſtoney concretions in the urinary paſſages; whileſt thoſe with the marine acid are found to prevent and break ſuch concretions.

§ 370. Hence, theſe waters are not to be dreaded, in theſe circumſtances; but may, with ſafety and propriety, be drank by calculous and gouty patients; and I am well perſuaded, theſe ſprings and pumps will

will be found more truly medicinal, than many of thoſe, that are deemed ſo; and as ſuch, have their ſources much frequented, and their waters tranſported to various remote regions.

### *Of the medicinal Qualities and Uſes of* WATER.

§ 371. It were happy for the moderns, they had kept up ſome degree of that veneration for water, which was payed to it by their more wiſe anceſtors. How uſeful and neceſſary it muſt prove to all the terreſtrial creation, may be eaſily conceived from the premiſſes. It is in an eſpecial manner neceſſary to the animal kingdom, and of thoſe, that can live out of that element, to none more ſo, than to the human kind: in ſo much, that, to me, there ſeems great reaſon to apprehend, that the health, and even the ordinary term of life of man, have ſenſibly declined and ſhortened, in proportion as water has become neglected or diſuſed.

§ 372. The antients looked upon water as the material cauſe or firſt principle of all created things. The firſt philoſophers, who gave this as their opinions, were * THALES MILESIUS, and EMPEDOCLES. They had many followers. Among the moderns, † PARACELSUS ſtarted the ſame doctrine, aſſerting water to be at once the ſeminary and matrix of all created beings, or to contain in it actually, as well as eſſentially, not onely vegetables and animals, but minerals alſo, not excepting the moſt perfect gems and metals. From this rambling philoſopher's opinion, VAN HELMONT did not much vary. And though all theſe, to more cool and better enlightened enquirers, appear to have exaggerated in their notions; yet, all muſt confeſs, that without water, there could be no generation or procreation of any bodies of whatſoever ſpecies in the mineral, vegetable, or animal kingdoms. Hence,

* Diog. Laert. in Vit.

† Param. lib. iii. meteor. lib. cap. 3. de peſt. tr. 1. et paſſim.

ſome wittily, if not truly, derive the etymology of the latin name of water, Aqua, from à qua omnia fiunt; that, out of which all things are produced.

§ 373. The ancient heathen did not think they diſhonored or leſſened their gods in deducing their origine from water.*

§ 374. A great part of the religion of the ancient heathen, as well as of the Jews, conſiſted in waſhing. How far phyſic and good policy contributed to give riſe to the cuſtom of waſhing, eſpecially in hot countries, is not, at this day, eaſily aſcertained; though, it is probable, one or both bore a part in inſtituting that, which religion afterwards more ſtrictly enforced. Be that as it may, it is certain, no perſon, of either perſuaſion, was deemed clean, or judged qualified either to ſacrifice or pray to the gods, who had not firſt been cleanſed and purified by waſhing. Without this, † neither was to expect his prayers or ſacrifice acceptable. Hence, the cuſtom of waſhing of hands became ſo neceſſary a ritual in ſacrificing, that the greek word ‖, uſed to ſignify to waſh the hands, ſerved alſo for the expreſſion, to ſacrifice.

§ 375. The inhabitants of part of the Eaſt-Indies, to this day, pay the ſame religious regard to waſhing. Whence, immerſion in the river Ganges, is looked upon, by them, equal to an expiatory ſacrifice, with others. It is not improbable, the ceremony of ſprinkling with holy water, in the new roman religion, and that of dedicating ſweet, as well as medicinal, ſprings and natural baths, by the votaries of that religion, to ſome of their ſaints, ſprung from the ſame ſource, and in proceſs of time, and ignorance, degenerated into ſuperſtition.

* Ὠκεανὸν τε Θεῶν γενεσιν, καὶ μητέρα Τηθύν. HOMER. Iliad. lib. xiv.
Where the great parents (ſacred ſource of gods)
Ocean and Tethys ——— ——— ——— POPE.

† Homer. Odyſſ. lib. ii. and the books of Moſes.

‖ Χερνιπλεῖν.

§ 376. What

§ 376. What or how elementary water may contribute to the generation or accretion of the different bodies of the creation, I ſhall not attempt to explane further in this place. Let it ſuffice to obſerve, that beſides making an eſſential conſtituent part of moſt bodies, it is, undoubtedly, the vehicle of nutrition to all the creation. The beſt philoſophers agree, that all things were ſome time in a fluid form; and we may preſume, it muſt have been aqueous fluidity.

§ 377. No vegetable or animal can ſubſiſt long without water; and it is certain, that, ſince the creation, water has been the common drink of men as well as of brutes. Hence, water may well be reckoned the moſt valuable liquor produced by nature or art. The wiſdom of the Creator appears in none inſtance more manifeſt, than in the vaſt plenty in which he has ſupplied his creatures univerſally with this neceſſary fluid; though moſt of them, even the rational, have been ungrateful and inſenſible enough to forget and deſpiſe his providence and bounty, in making this beneficent, this parent liquor, ſo common.

§ 378. From the creation to the univerſal deluge, which is calculated by divines to have made a ſpace of ſixteen hundred years, we are told, that neither wine, nor any other fermented liquor, was known; ſo that water was man's chief drink during that time. We learn from ſcripture, that men lived then to a thouſand years. I will not preſume to ſay, that this longaevity was ſolely owing to the uſe of water; but, I think it no preſumption to conclude, that, in thoſe days, in which men lived neareſt the ſimplicity, that nature dictates in all her works, they were then moſt healthy, and lived the longeſt. Water was the onely drink the Almighty prepared for his creatures, after a certain age; and had any other been neceſſary, he could not have been wanting. in his unbounded knowledge and providence, in producing it. It muſt be confeſſed the pureſt, the ſimpleſt, the moſt natural, and, I had like to have ſayed, the onely proper drink for all grown animals.

§ 379.

§ 379. Let us conſider the conſequences of having introduced other drinks. Noah, of our ſcriptures, who is agreed to have been the Bacchus of the heathen, is deemed the inventor of wine: With the uſe of which, a worſe deluge than the general, a deluge of luxury and vice, overrun the world. Diſeaſes of body and mind were introduced; ſo that men did not live to above a tenth of the age of the antediluvians. Thus, the royal pſalmiſt in his penitentials, after having perpetrated every vice, that any monarch or ſubject ſince his days could boaſt, and contracted the foulеſt diſeaſes, that ever rendered a libertine's life miſerable and burthenſome, exclames, that the days of man are limited to three ſcore and ten years. Whereby it is obſervable, that the further men receded from the ſimple courſe of diet and manners, which wiſe and provident nature, or her great and omnipotent author, pointed out, the more immoral and profligate they became, and the ſhorter they cut the thread of life.

§ 380. The ancient Perſians, as well as the Parthians, eſteemed water the beſt drink: For, we are told of their kings, that they drank nothing but water; of which they were very chary, as well as cautious in their choice.* Hence, their monarchs reſerved to their own ſole uſe, the water of the river Eulaeus, according to Strabo, and that of Choaſpes, according to Herodotus. Of theſe, no ſubject was permitted to drink under ſevere penalties. This author attributes the longaevity of the Ethiopians, who, as he ſays, lived to one hundred and twenty years, to the uſe of their waters, whoſe ſubtility and levity, he obſerves, to be ſo remarkable, that no body, not even wood, could float on them.†

§ 381. The ancient Romans were very ſparing in the uſe of wine. Some of their hiſtorians‖ aſſert, that wine was not drank among them for four hundred

* PLIN. Hiſt. Nat. lib. xxxi. c. 3.
† Lib. iii. c. 125.
‖ JULIUS FRONTINUS.

and

and fifty years after the building of the city. They were then hail, robuſt, vigorous, valiant, and virtuous: But, as riches increaſed, and their attendant luxury crept in, they changed their ſimple way of living for a more ſumptuous: Inſtead of water, they drank wine. And the conſequence was, that in proportion as they indulged in the uſe of wine and other delicacies, ſo they fell off from that happy diſpoſition of body and mind, that rendered them the objects of admiration, envy, and terror of the reſt of the world; they became weakly, ſickly, diſorderly, daſtard, corrupt; and at length, exchanged the two greateſt bleſſings of life for the worſt curſes; health and freedom, for diſeaſes and ſlavery. And thus, we have the teſtimony of former ages concurring with what is obſervable in our days, that the healthieſt, longeſt-lived, and happieſt people, are found among thoſe, that drink water rather than fermented liquors.

§ 382. From this, and many other conſiderations, I am induced to be of the ſame opinion with the learned HOFFMAN, who ſays, that if there be in nature a medicine, that deſerves the title of univerſal, it is water.* This will be rendered more evident by conſidering, with the properties, qualities, and effects of water, the nature and ſtructure of the human frame. Let us then begin with the later conſideration, as the former fell, in part, already under our obſervation.

§ 383. The body of man conſiſts of various heterogeneous parts, and is of a very lax and fragile texture. It is liable to an infinite variety of diſaſters, and hardly ever to be pronounced in a perfect ſtate of health. It ſtands in need of continual ſupplies from without, for its nouriſhment and ſupport; and, as it muſt neceſſarily take in more food, than it can aſſimulate, or diſpenſe withal, it is providentially furniſhed with means of throwing off uſeleſs and ſuperfluous matters, by certain excretory ducts and pores. For theſe purpoſes, it muſt be furniſhed with a great variety of or-

* De Aq. Medicina univerſ.

gans

gans or machines for comminuting, digeſting, moving, ſtraining, applying, uniting, or ſeparating the ſeveral parts of the received aliments, as they are fitted and deſtined to ſupport different parts of the whole frame, and to caſt off redundancies and recrements.

§ 384. This wonderful congeries of machinery, the work of ineffable wiſdom and power, is conſtructed of ſuch materials as this lower creation affords, periſhable matter; ſo that every organ is worn, and in ſome ſenſe injured, by the very function it performs for its own and the general ſupport of the oeconomy.

§ 385. Thus, all the parts of this complicated, yet moſt regular machine, whether they miniſter to the vital or animal functions, the involuntary actions neceſſary to life, or thoſe directed occaſionally by the impulſes of the mind, are all, in ſome degree, worn or impared in the very action. As, for example, the teeth ſuffer in maſtication or chewing the aliments; the tongue and throat in deglutition or ſwallowing; the ſtomach and inteſtines in digeſtion and excretion; the heart and blood-veſſels in the circulation of the blood; the brain in elaborating the nervous fluid or ſpirits; the ſeveral glands in ſecerning their peculiar juices; the lungs in inſpiration and reſpiration; the muſcles and joints in motion; in ſhort, every organ, even the ſeveral ſecretory and excretory ducts and pores, muſt ſuffer in the performance of thoſe very offices, without which the animal can not poſſibly ſubſiſt.

§ 386. This ſtupendous frame conſiſts of ſolids and fluids. The ſolids are all vaſcular, and conſiſt of elaſtic fibres; and as they receive their accretion and nutrition from the fluids, ſo they contain them, and promote their free and equal diſtribution by an univerſal, regular circulation. Thus, the ſupport and preſervation of the whole depends on motion: For, while the fibres retain their due tone, they will receive and propel the contained fluids, and thereby paſs them through all the canals, from the greateſt in the heart

to

to the moſt minute in the extremities, by a ſucceſſive and reciprocal dilatation and contraction. By this regular motion the ſolids nouriſh and repare themſelves, and preſerve the neceſſary fluidity of the juices.

§ 387. While the due tone of the ſolids, and the neceſſary fluidity of the juices are perfectly preſerved, the body muſt ſubſiſt in health. This might be perpetual were not the materials, of which the whole is compoſed, periſhable, ſubject to an infinite variety of viciſſitudes, which, in time, muſt bring on corruption or diſſolution.

§ 388. From the nature of the aliments, and the very air, that ſurrounds and ſuſtains the body of man, the fluids and ſolids are variouſly affected; either by working an immediate change in the juices, which muſt mediately affect the ſolids, or by immediately altering the ſolids, which muſt mediately affect the juices.

§ 389. Whileſt the juices are preſerved of a mild, bland, balmy diſpoſition and due conſiſtency, they furniſh the ſeveral ſolid parts with proper ſupplies; and the ſolids, in their turn, perform their functions uniformly, regularly; but, if they be altered from this due diſpoſition and conſiſtency, and are rendered in any degree acrid, ſharp, and thin, or groſs, viſcid, and thick, an unequal tone of the ſolids muſt be induced, and an unequal diſtribution and circulation of the fluids themſelves muſt ſoon follow. On the other hand, if the ſolids be firſt, or immediately, affected, ſo as a tenſion, or criſpature, or a relaxation of the fibres, be produced; an undue motion of the ſolids will thus be brought about; and the juices, whoſe well being, in an eſpecial manner, depends upon the ſolids duly performing their functions, muſt ſuffer an unhealthful change.

§ 390. By changes thus wrought in the frame of man, foundation is layed for an endleſs variety of diſeaſes, which, ſooner or later, lead to final diſſolution. But, ſhould theſe be avoided to old age, the ſame

end is but more ſlowly brought about; for, the fibres by time grow more ſolid, dry, hard, and rigid, the veſſels are, of courſe, diminiſhed, and the pores contracted. Hence, the fibres gradually abate of, and at length totally loſe, the faculty of motion; by which alone the juices may be circulated for the mutual ſupport of the whole. That this hardneſs and rigidity of the fibres, &c. is brought about, appears not onely from the view and diſſection of old bodies, in which the ſkin is hard and dry, many vaſcular parts are found quite ſolid, and not only cartilages and tendons, but ſeveral portions of the arteries themſelves, are converted into ſolid hard bones,* but alſo from a well known obſervation in cookery, that the fleſh of old animals requires longer time to boil, bake, or roaſt, than that of young.

§ 391. From this ſhort ſketch ofphyſiology, a rational idea of the cauſes of health and diſeaſes of the human body may eaſily be conceived; and the operation of medicines, which depends not upon their activity alone, but is the joint reſult of a mutual, mechanical action and reaction of the remedies and the animal oeconomy: For, did the operations of medicaments depend ſolely upon their power of acting, the ſame effects would be produced in all bodies alike, even in dead, as well as living ſubjects; the contrary of which our common ſenſes evince. Hence, appears the groſs impoſture of thoſe, who pretend to an univerſal medicine, that is, one remedy capable not onely of preſerving the health and life, but of curing all diſtempers and diſeaſes incident to the human frame; and for this purpoſe give their pretended remedies, indiſcriminately to all, without regard to differences of ſexes, ages, conſtitutions, climates,

* Of this, I have a remarkable inſtance by me; the great artery of an old ſubject I diſſected, under the conduct of that minute anatomiſt, great phyſician, and excellent man, M. PETIT, in Paris, of which ſeveral portions, even of the crural branches, are completely oſſified.

ſeaſons

ſeaſons of the year, or other circumſtances. How hardly do they deſerve to be undeceived, who ſuffer themſelves to be duped by ſuch impoſtors!

§ 392. Let us now examine what clame water may lay to the titule of an univerſal remedy. It is certainly, of all known creatures, that, which has the faireſt pretenſions to that appellation; ſince it is demonſtrable, that nothing is found ſo generally uſeful and beneficent, ſo neceſſary to the preſervation of the health and life of man, and ſo inſtrumental to the cure of the variety of diſeaſes to him incident, as water. In a general view, water may well be looked upon as the univerſal medicine. In one ſhape and proportion or other, it agrees with all temperaments, ages and ſexes; may be taken, more or leſs, in all climates and ſeaſons; and without it, in ſome form, no man or other animal can ſubſiſt. Then, in all diſeaſes, whether acute or chronic, when properly applied, it is found a moſt excellent, a moſt powerful remedy, and equally anſwers the preſervative and curative indications.

§ 393. But, it merits a more particular attention. The ſuſtenance of the animal body depends upon the comminution or ſolution of the more ſolid aliments; whereby they are fitted to be carried through the various infinitely ſmall ſtrainers and tubes of the body, and applied to the ſeveral parts and uſes of the oeconomy, for which they are deſtined by the laws of nature. This can onely be done by the means of water; as that is found the moſt univerſal ſolvent of the food of man and other animals. Then, as the fluidity of the juices of the beſt nouriſhed body, on which their equal diſtribution and free circulation depends, muſt be owing to water; the fitneſs and neceſſity of this liquor, to all conſtitutions, to all ages, to both ſexes, and in all ſeaſons and climates, muſt evidently appear.

§ 394. The blood, that heterogene maſs of humors, from whence, not onely all the other fluids of the body are ſecerned, but the moſt hard and ſolid

parts

parts derive their origine and continual ſupport, conſiſts of ſubtil terrene, oily and ſaline parts, blended with a very conſiderable quantity of water, and by motion kept in ſo fluid a ſtate, as to be capable of paſſing through veſſels too minute for deſcription; but, upon ſtagnation, moſt apt to ſuffer a ſeparation, to run into grumous coagulations, to form obſtructions in the veſſels, to corrupt and putrify.

§ 395. Upon diſtilling or evaporating the blood of an healthful perſon, in an heat not exceeding that of boiling water, it will be ſeparated into two parts, the one a black, hard, ſolid, and hardly ſoluble maſs, which by its inflammability proves its containing oil, and being burned, by elixiviation yields, a ſimple earth and a ſalt, analogous to ſea ſalt. This makes one part of the maſs. The other is pure inſipid water, ſlightly ſmelling of the blood, and conſtitutes two parts of the whole. Thus, twelve ounces of blood, by this treatment, is commonly found to contain about four ounces of this mixed ſolid matter, and about eight ounces of this ſimple water.

§ 396. The health of the body depends upon the due proportion and intimate mixture of theſe materials in the blood. The redundance of any, eſpecially of the ſolid parts, lay an immediate foundation for ſome diſeaſe; the want of any, eſpecially the aqueous parts, alike brings the body to a diſtempered ſtate. Health depends upon the equilibrium being preſerved; but, the oeconomy can beſt diſpenſe with the redundance of water: If the ſolid parts preponderate, all the animal functions in general ſuffer; the circulation becomes languid and unequal, the juices ſizey and viſcid; obſtructions, tumefactions, indurations of the bowels and glands are formed; inflammations, general or partial, are brought on, ſubject to apoſtemation, perhaps, to gangrene and ſphacelation. This evil is remedied by reſtoring its due proportion of aqueous humidity to the blood. By this, the humours acquire the juſt and

neceſſary

neceſſary fluidity, a free circulation and all the animal functions are reeſtabliſhed; the veſſels are dilated and opened, obſtructions removed, tumors and indurations reſolved, the ſecretions and excretions promoted; the predominant or diſproportionate ſolid matter, which is to be deemed foregne and noxious, whether terrene, ſulphureous or ſaline, is diſſolved in its proper diſſolvent and waſhed and carried off by the proper emunctories.

§ 397. Thus we ſee, it is water, that diſſolves or liquefies our ſolid aliments and extracts from them the Chyle, from whence the maſs of blood is formed. It is water, that preſerves all the juices in a liquid ſtate, in which alone a free and vigorous circulation of them can be ſupported. By ſuch a circulation, the matters fit for the accretion and nutrition of the different ſolids are depoſited and applied to the deſtined parts; the moſt ſubtil nervous fluid, the cauſe of motion and ſenſation, is elaborated and ſecreted; whileſt all foregne, or uſeleſs matters, all redundancies and recrements are excreted.

§ 398. Hence, it is eaſy to conceive what this ſimple, and too much deſpiſed liquor does and may contribute to the ſuſtenance of human life, to the preſervation of preſent, and to the reſtoration of loſſed, health; and why water drinkers in general are more healthy, vigorous, and cheerful, more prolific and longer lived, than thoſe, who uſe wine and other fermented liquors for their drink.

§ 399. This is obſervable, not only in the poor of all countries, as well as our own, whoſe penury prevents the uſe of fermented liquors; but alſo in thoſe of better condition in other countries, who have the prudence to make water their principal drink. Thus it is in Italy, Spain and France, where the well bred youth of either ſex are hardly allowed or known to taſte wine, and it is a reproach to any grown perſon to drink much. Water, either pure or ſlightly tinged with wine, is the common draught of perſons of

the beſt quality at their meals. Nor are they, like us, afraid to drink water after Fiſh or Fruit, of which they eat more than we do; and yet find water agree better with them, than fermented liquors with thoſe, who are led by a kind of hereditary infatuation into the uſe of pernicious ſpirituous draughts, not onely at meals, but at all hours between them. This ſhameful charge, with all its deſtructive conſequences, falls to the lot of Germans, Dutch, Britons and Iriſh.

§ 400. Thus far we have conſidered water as it contributes to ſuſtain the life or to preſerve the health of man. Let us now conſider how far it is or may be inſtrumental in the cure of the diſeaſes incident to the human frame, in reſtoring loſſed health.

§ 401. Phyſicians diſtinguiſh all diſeaſes into acute and chronic. By acute, thoſe diſtempers, whoſe acceſs is ſudden, and whoſe progreſs is rapid, violent and dangerous, terminating happily or unhappily within a certain ſtated ſpace of time, are underſtood. Of this claſs are all Fevers, which terminate on certain critical days. The idea of a Fever conſiſts in a violent and preternatural motion of the ſolids, whereby the Fluids are neceſſarily propelled with unnatural and intolerable Velocity. This is always an effort of nature to ſhake off ſome noxious or morbific matter; in which ſhe either ſuccedes, and the patient recovers; or fails, ſo that he either dies, or gets through with ſome parts ſo vitiated, as to lay foundation for diſeaſes of the other kind, within a certain term. If by proper evacuations, ſuch as by Veneſection, where the blood is peccant in quantity as well as quality, by emetics or purgatives, where the firſt paſſages are affected, or by diaphoretics, where the ſubtil poiſon may be diſcharged by the pores of the ſkin, and theſe timely applied in the beginning of the diſeaſe, the patient be not relieved; then the chief help, the phyſician can give, is to reſtrain the violence of the motion or furniſh the oeconomy with ſuch matter, as will render the violent and inordinate motion leſs injurious and

 more

more tolerable. The method of doing this, nature herſelf generally points out. As by motion, heat is produced, and by that heat, raiſed beyond due bounds, the friendly balmy fluid, neceſſary to keep the common maſs of humours in a fluid ſtate, muſt be altered, waſted or diſſipated; the patient grows thirſty and calls aloud for water or watery liquors to drink. Water is then, his principal, if not ſole, remedy: This corrects the heat, cools and thins the blood, ſoftens and lubricates the arid and criſp ſolids, diſſolves and waſhes off foregne and noxious matters, and, in ſhort, reeſtabliſhes the vital and animal functions, and reſtores deſired health. Hence, the moſt obſervant and judicious phyſicians, whether antient or modern, have always layed a great ſtreſs on the plentiful drinking of water, either ſimple, or ſlightly medicated with ſome convenient vegetable ſubſtance, in the form of Ptiſans or Apozemes, in all ſimple Fevers; with this caution, that it ſhould not be given too cold. Were not this one of the beſt, the moſt univerſal of remedies, what muſt become of the poor in this and other nations, where they can not often procure any other medicine, and are ſometimes forced to rely on it for their principal ſupport?

§ 402. Chronic diſeaſes are ſuch, as are ſlow in their acceſs and progreſs, and continue long, without any ſtated time of determination. Theſe generally ariſe from a fulneſs and viſcidity, or ſome particular impurity of the juices, gradually induced, which brings on obſtructions of the bowels and glands, unequal and imperfect circulation, ſecretion and excretion. Such are the ſcurvey and ſcrophulous diſorders, the ſtone and gravel, the gout and rhumatiſm, &c. for the whole train of which, water has been found the moſt potent, the moſt univerſal remedy.

§ 403. Of this, further proofs and inſtances ſhall be offered in treating of the mineral waters, which have been found moſt effectual in many chronic diſtempers. That their efficacy did not depend upon

their ſolid contents, whether terrene, metalic, ſulphureous or ſaline, may be judged from theſe conſiderations, 1. that ſuch contents given without being diſſolved in, and diluted with, a conſiderable quantity of water, would prove fruitleſs, if not hurtful. 2. That many of the moſt ſimple ſprings and baths have been found ſovereign remedies in a great variety of chronic affections. This has proved a fatal ſtumbling block to many practitioners in Phyſic; who, being ignorant of the qualities and effects of ſimple water, in order to enable them to conjecture the qualities, or to explane the effects of ſuch waters, by the operation of ſome drug, with which they might have had ſome ſlight acquaintance; have tortured their own brains and the waters of divers healthful ſprings to find out or aſcribe principles to them, which the wiſe Creator never gave them. Thus, a medly of all the mineral kingdom, a chaos of ſalts, as ſome * call it, were given to the waters of Aken; ſulphur, bitumen, an alcaline ſalt, and nitre, to thoſe of Bath; Allum and Lime-ſtone, to thoſe of Briſtol; Nitre to thoſe of Scarborough, Cheltenham and other purging ſprings, and mercury to the periodical baths of Pfeffer, &c. the falſehood and abſurdity of which, we ſhall ſet forth in treating of theſe waters ſeverally. But, to ſhew, that ſimple ſpring water, either cold or heated, in its paſſage through the earth, is found a powerful remedy in many inveterate chronic diſeaſes, let us attend to the effects produced by thoſe ſprings, to which the ſuperſtitious reſort, expecting aid from the tutelar or imaginary preſiding ſaint, to whom the waters are ſuppoſed to be conſecrated. To theſe, let us add thoſe famous waters mentioned by HOFFMAN in the tract before cited; ſuch as the pure, light, ſimple waters of Schleuſingen in the Principality of Henneberg, in Germany; by which the Gravel and Stone, Gout, Rheumatiſm, Scurvey, ſtiffneſs and weakneſs of the joints and limbs,

* Flondel, de Therm. Aquiſgr. & Porcet. and his followers and tranſcribers.

and

and obſtructed Menſtrua and Hemorhoids are relieved; the like waters not many years diſcovered in the Black Foreſt near Oſterod, which, upon examination, afford not a grain of any ſolid mineral matter; yet, are found effectual in the preceding diſtempers, as well as in inveterate diſorders of the head, weakneſſes of the limbs and choleric and hypochondriac affections. To theſe may be added the Baths of Toeplitz, in Germany, the famous thermal waters of Pfeffer, in Switzerland, which we have already mentioned, as none other, than ſnow water warmed by a ſubterranean heat; for, they are found void of mineral ſpirit, as well as of all ſolid matter; yet, they are powerful remedies for all diſorders ariſing from mucous, ſaline or tartarous concretions, as contractions or rigidity of the joints, gravel and ſtone, ſcurvey, gout and rhumatiſm, &c. And notwithſtanding, theſe waters are as ſimple and pure, as any water can be conceived; they are ſoft and light, as rain water; and have no more appearance of mineral ſpirit, of ſalt or ſulphur, or other terrene matter, than that: They ſuffer no change upon the addition of acids or alcalies, nor cauſe any precipitation upon the mixture of ſaline or metalic ſolutions.

§ 404. The ſame may be ſayed of a bath in Heſſe, called das Schlangenbad, the ſerpent's bath, as alſo of the waters of Piſa, Tettuccia, Noceria, and many others in Italy; as well as of a remarkable ſpring in Iceland, whoſe heat is equal to that of boiling water, though it be as ſimple, as that of rain.

§ 405. We ſee then, that reaſon and experience demonſtrate the extenſive, the univerſal uſe of water in food and medicine. It was deemed a ſubject to write on, worthy of the pens of many of the antients, as well as * Hippocrates, who wrote expreſly on water.



* De Liquid. uſu. et DeAere Aquis & locis. Quicunque artem medicam integre aſſequi velit, primo temporum anni rationem habere debet, deinde ventorum, qui cuivis regioni proprij. Neque negligentiorem

And certainly, that phyſician, who is unacquainted with the nature and quality of waters in general, eſpecially of thoſe, that are uſed where he practices, is but poorly furniſhed with means of preſerving or reſtoring the health of his patients.

§ 406. If authority be wanted to ſupport the uſe of ſimple water in numberleſs diſeaſes, it may be had by conſulting the works of the graveſt and beſt practical writers.

§ 407. RIEDLINUS, an author cited by HOFFMAN, recommends water in melancholy madneſs; and ſays, that rain water, taken like mineral water, firſt in a ſmall quantity, increaſed gradually to a conſiderable pitch, continuing it ſo for ſome days, and then gradually diminiſhing it, cures cachectic and conſumptive perſons.

§ 408. RIVERIUS [a] ſays, that by the continued uſe of ſimple water alone, he has known the ſuppreſſed menſtrual courſes reſtored, better than by more pompous emenagogues.

§ 409. CELSUS [b] earneſtly recommends the uſe of cold water in diſorders of the head, as the mur, or ſtuffing of the noſe, bleardneſs or inflammations of the eyes, defluxions on the glands of the throat, &c.

§ 410. SYLVATICUS [c] warmly recommends it in red and pimpled faces and other erruptions of the ſkin, and in choleric heats of the liver.

§ 411. So effectual has ſimple water been found in the gout, in France, that it is called the Capucin's remedy; becauſe the Friars of that order, by water-drinking, keep clear, or cure themſelves, of that diſorder. Agreeable to this, is what MARTIANUS in his commentary on HIPPOCRATES aſſerts; Cardinal

rem ſe circa aquarum facultates cognoſcendas exhibere conveniſt. Quem admodum enim guſtu differunt et pondere et ſtatione; ſic quoque virtute aliae aliis longe praeſtant; has, ſi quis ad urbem ſibi incognitam perveniat, diligenter oportet ſcrutari.

[a] Oper. lib. iv. c. 24. [b] Lib. i. cap. 15. [c] Cap 1. Obſ. 1.

Ber-

Bernerius his having been perfectly cured of the gout, by drinking cold water onely. To this RONDELETIUS [a] ſubſcribes, when he aſſerts, his having cured many perſons of the gout by plentiful drinking of cold water; which ſucceded beſt in thoſe of bilious habits.

§ 412. But, as cold water may be diſagreeable and hurtful to perſons of cold conſtitutions and weak nerves; for ſuch, either the natural hot ſpring water, and next to theſe any ſimple waters warmed are moſt proper. Theſe are countenanced by AVICENNE [b]. Such waters taken upon an empty ſtomach muſt be ſerviceable in all diſorders ariſing from a foulneſs of the inteſtinal channel, or a thick and viſcid ſtate of the juices.

§ 413. Let no man be deceived in attributing ſolely to the herbs or other drugs, with which water is impregnated, ſometimes diſguiſed, in Apozemes, Decoctions or Infuſions, or to ſprings ſlightly tainted with minerals, the effects, by the compoſition produced. Such Drugs given by themſelves would often be found, as ineffectual, as the ſolid contents extracted from mineral waters are obſerved. Their efficacy is chiefly, if not ſolely, owing to the water alone; and in many caſes, ſimple, pure water would be found to produce the ſame or equal effects, with theſe more pompous compounds. Yet, ſuch have their uſes in many caſes, where ſomething well adapted to the patient's particular caſe, may be conveyed by the means of that moſt univerſal ſolvent and excellent vehicle, water.

§ 414. Moſt chronic and many acute diſeaſes deduce their origin from a Plethora, or fulneſs. This is beſt prevented or cured by the uſe of water: For, by thinning or diluting the blood, it prevents thoſe morbid coagulations and concretions, which lay a foundation for all diſorders ariſing from obſtructions; or, by diſſolving them when formed, fit them for circulation, and waſhes away all impurities and ſaline recrements

[a] Prax. p. 611. [b] Lib. i. Sect. 2. c. 16. p. 102.

from the mafs of humors, determining them by the moft convenient emunctories.

§ 415. To facilitate the natural difcharges, water foftens and opens the fecretory and excretory tubes in general, and thereby promotes the rejection of all ufeleſs or offenfive matters in them contained. It keeps the body duly lax and free, promotes urine, and by waſhing and cleanſing the urinary paſſages, prevents calculous concretions. Water, at the ſame time, that it keeps all the humors in due fluidity, opens and cleanſes the pores of the ſkin, by which tranſpiration, of all others the moſt beneficent and neceſſary evacuation, is regularly kept up.

§ 416. From theſe conſiderations, it is not difficult to conceive how water becomes uſeful and neceſſary in all conſtitutions, to all ages, and to both ſexes. In ſanguine habits, it keeps up ſuch a fluid ſtate of the maſs of humors, as is neceſſary for a free circulation; without which, ſuch muſt be conſtantly expoſed to obſtructions and inflammations. In the choleric, it attemperates the inordinate motion and conſequent heat of the ſolids, by blunting and correcting the acrimony of the juices, and promoting a diſcharge of the redundant ſaline and ſulphureous parts by the proper excretory pores and ducts. By thinning and reſolving the viſcidity of the blood, it remarkably helps the melancholic and phlegmatic.

§ 417. Water not onely agrees, but is neceſſary to the well being of man in all ages. Infants are ſubject to many diſorders from the viſcidity and aceſcency of the milk, which makes the chief part of their diet. In the puerile ſtage of life, various diſorders ariſe from a viſcidity of the juices, occaſioned by the redundance of nouriſhment: In the adult or manly age, we are expoſed to the like diſorders, and to inflammations and fevers; and in old age, the fibres are apt to grow rigid, the ſmall tubes and pores become ſolid or obſtructed, and all the vital and animal functions become languid and irregular. In all

theſe

theſe ſtates and caſes, water muſt give the moſt powerful help; for reaſons, which, I hope, are obvious from what has been before offered.

§ 418. Water is well appropriated to either ſex, whoſe diſorders, in general, requires a ſimilar treatment, as the organs, which perform the vital and animal functions, are in both alike. In either, the obſtruction of the menſtrual, or ſuppreſſion of habitual hemorhoidal, fluxes, alike brings on dreadful diſorders. In both, theſe diſcharges are effectually reſtored by a proper uſe of water.

§ 419. Water then ſhould be drank at meals from the infant ſtate to the laſt ſtages of life. In general, the quantity ſhould not be leſs than triple the weight of the ſolids conſumed. As a medicine, in all proper caſes, it may be drank to aſſuage heat and thirſt, to cleanſe the firſt and ſecond paſſages, to dilute the blood and other juices, and to take off the tenſion of the ſolids; beginning with ſmall quantities, increaſing them gradually, till they are found to anſwer, and then diminiſhing the doſe in the ſame time and proportion, as it was augmented.

## *Of the topical uſes of Water.*

§ 420. Hitherto, we have conſidered the internal uſe of water. Let us now examine it as a topical application, in which we ſhall not find it much leſs effectual, or leſs univerſal.

§ 421. As it is probable, the firſt diſorder known to man was local and external, ſome foulneſs or injury of the ſkin, ſtrain, bruiſe or wound, and water preſented itſelf in moſt places, it is likely, that this benign fluid was the firſt topical application. Its uſe in medicine, as well as food, no doubt, became early known to man. Nor do we find the brute creation ignorant of its uſe in either intention. The moſt antient writers in the healing art mention bathing, warm and cold, as a well known and proved remedy. And there

there is hardly any credible account of any people on the globe at any time ſo rude and barbarous, as not to know the uſe of bathing.

§ 422. We have before touched upon the antiquity and univerſality of the cuſtom and uſe of waſhing. It is not here neceſſary to expatiate much further on that ſubject: The medicinal, not the ritual or religious, uſe of water is the object of this diſquiſition. We find then, in all countries and in all ages, of which we have any authentic hiſtories, Bathing was held in univerſal, high eſtimation. Thus, in every city in antient Egypt, magnificent baths were built for public and private uſe. The Greeks followed the example of the Egyptians, as the Romans afterwards embraced that of Greece. By bathing, theſe people ſought the preſervation of preſent, and the reſtoration of loſſed, health. Nor were they fruſtrated in their expectations: For, theſe ends were eaſily anſwered to a frugal, moderate people; and the good effects of theſe ſalutary applications were obſerved and recorded by the moſt antient writers, and the practice, by them authoriſed, handed down to poſterity; as may be ſeen in the works of HIPPOCRATES, GALEN, ARETAEUS, TRALLIAN, AETIUS, CELSUS, CAELIUS AURELIANUS, &c.

§ 423. The Greek and Roman luxury appeared in nothing more evident, than in the magnificent ſtructures, they erected for their Baths. It has ever been the fate of the moſt powerful remedies, that men could not be contented with the uſe of them upon extraordinary occaſions and in caſes of neceſſity onely, but they muſt luxurioufly introduce them into the common oeconomy of life. Thus wine, and other fermented and ſpirituous liquors, tea, ſnuff, and many other uſeful creatures, are, by their abuſe, in our days, ſo perverted, as, at beſt, to be rendered uſeleſs to thoſe who are accuſtomed to them, and too frequently to be found deſtructive. This, ſoon after their eſtabliſhment, became the fate of baths: It was no ſooner made known to be neceſſary, to the preſervation

vation and reſtoration of health, to bathe on certain times and occaſions, than every one ran into the promiſcuous uſe of the pleaſing application. Hence, the Emperors and other great perſonages raiſed thoſe ſuperb ſtructures to adorn their baths, of which we find mention made, not onely by the Poets, by Statius, Martial, and others, but by more grave and ſerious writers, ſuch as SENECA[a], PLINY[b], and VITRUVIUS[c]. Of this kind of building, ſeveral great ruins ſtill remane in Rome and Italy, monuments of the luxury, as well as magnificence of their founders. In proceſs of time, baths became chiefly uſed for pleaſure and recreation; as we find Charlemagne received his levee in a great bath, in his favorite city, Aken. Such abuſe could not fail of bringing baths to diſcredit and diſuſe. As this too frequent and promiſcuous uſe of them muſt have often produced evil, as well as good, effects.

§ 424. But, though the abuſe of the beſt medicine ſeldom fails of bringing it into general diſrepute; phyſicians ſhould procede upon more rational principles, than to ſuffer little, mean popular caprices to affect their practice, or diſcountenance the uſe of theſe good things, which reaſon and experience recommend. When they have the teſtimony of the wiſeſt of all ages and nations to convince them of the ſalubrious uſe of rational bathing, how can they ſuffer themſelves to be diſcouraged from the uſing it, by any evils produced by its abuſe! Let it not be aſked—Phyſicians are but men. Phyſic is become a trade; and ſince it became ſuch, it has too often fallen into the hands of mean, ſervile and mercenary men, to eſcape the deſpicable frauds and artifices, that have over-run moſt of the trades and employments of life. The public is ever captivated with novelty, and ever reveres things ſeeming ſecret and myſterious. Hence, as new modes and faſhions become the life of trade, Phyſic, the no-

[a] In Epiſtol. [b] Hiſt. Natur. [c] De Architectura.

bleſt

bleſt art known to man, has been made to ſtoop to the ſame vile craft and artifice, and to put on the ſhameful maſk of obſcurity, to ſerve the ſame baſe ends,—ſordid gain!

§ 425. In ſuch a general degeneracy, it is eaſy to conceive how medicines riſe and fall in common eſtimation, and ſuffer a rotation of faſhions like our cloaths. The frauds and impoſitions, the horrid train of ignorance, which neceſſarily attend this baſe practice, muſt be obvious to the meaneſt capacity. In theſe days, it is no wonder, we find numbers of phyſicians entire ſtrangers to the nature and qualities of ſome of the moſt valuable ſimples, and not daring, where they happen to know and eſteem a ſimple, common medicine, to preſcribe it; when they ſee vulgar prejudice take up arms againſt it, or find the popular folly ſuch, as to eſtimate the value of the phyſician, as is frequently the caſe, from the rarity, expence, or complicated preparation, or perhaps the inſinuated or imagined myſtery of the medicine, he preſcribes; or to make men run after a jugling ſecret-monger, who is not, in knowledge or rationality, three degrees removed from the brute, that draws the gilded chariot, in which he rides triumphant over phyſic, truth and common ſenſe. Who, in ſuch times, will preſume to preſcribe a plane, ſimple remedy, familiarly known to old women and nurſes? — The ſenſible, judicious, honeſt phyſician, who prefers the good of his patient and the peace of his own conſcience to riches, or the favour of a populace, which are too rarely obtained by better arts, than temporiſing, adulation, and ſervility. Had the phyſical world been better ſtocked with men of this caſt, or the populace more diſcerning, we ſhould ſee fewer quacks and other knaves make fortunes by the ſpoils of a deluded people; and medicines would not be rated by their rarity, or, as men are often, by the tinſel on their garments, the magnificence of their houſes, or the ſplendor of their equipages. Had a due regard to the intrinſec worth, not outward appearance, of medicines been

been kept up, water, now deſpiſed from its commonneſs and plenty, would have the firſt rank in the materia medica. How far it deſerves this claſs, we have endeavored already to ſet forth in part, in ſhewing the internal uſe of this element, and we ſhall further evince in explaning the various internal, as well as external diſorders, that are curable by the outward application of water.

§ 426. Water is not much more neglected in the internal uſe, than external application. To this, the former motives too much concur. But, another of the cauſes of the diſuſe of this moſt powerful, though common remedy, in the relief of inward diſorders eſpecially, ſeems owing to modern phyſicians laying out more time and pains in inveſtigating the nature and ſtate of the juices, than in examining, or attending to, thoſe of the ſolids. Had it been duly conſidered, that the free and equal circulation and diſtribution of the blood and juices in general depend upon the due elaſticity and vigorous tone of the fibres of the ſolids, as well as on the fluid and balmy temper of the juices, and that a more ſpeedy change may be often wrought in the ſtate of the ſolids by external, than internal remedies; water, which of all other creatures is beſt qualified to produce ſuch a change expeditiouſly, could not have loſſed ground in practice or the eſtimation of phyſicians. We ſhall in the ſequel endeavor to ſet this important, but much neglected matter, in a proper light.

## *Of* BATHS *in general.*

§ 427. Among the antients, there were various kinds and methods of bathing, which were either cold or hot, moiſt or dry.

§ 428. 1. The cold baths were always moiſt, conſiſting of cold, ſimple water, for the moſt part; though ſometimes, ſaline, chiefly ſea, water was uſed.

§ 429. 2. The hot baths were humid or moiſt, and dry. The humid or moiſt were chiefly ſimple

water, arteficially warmed, or ſimple or mineral water naturally heated in its paſſage through the earth in various Thermae or natural baths. The dry were alſo natural or arteficial; ſuch as Inſolation, or being expoſed to the heat of the ſun; ſalt or ſand heated by the ſun or by an ordinary fire; hot vapors iſſuing from mines; ovens and ſtoves, built for the purpoſe and heated by art; in which bodies were conveniently placed for the diſcharge of ſuperfluous humidity by the pores of the ſkin. To theſe may be added, Baths of fermenting or putrefying Horſe dung, or of preſſed or fermenting grapes, which are uſed in ſome countries, in chronic caſes, with great ſucceſs; and the Vapor Bath, that of any ſimple water duly heated, plane or impregnated with any appropriate medicine; or the vapor of ſome natural bath, charged with a ſubtil, volatile ſpirit, or with the eſſential principles of ſulphur, as the Baths of Aken, or Aix la Chapelle.

§ 430. In this place, it would be improper and foregne to our purpoſe to treat of any other, than the humid bathing, or the various manners of applying ſimple water to the human body externally, for the preſervation or reſtoration of health. In what eſtimation this remedy was held among the antients may be collected from [a] HIPPOCRATES, [b] GALEN, [c] ORIBASIUS, [d] STRABO, [e] PLINY, and others.

§ 431. The waters, which have been in uſe from all antiquity for bathing, are the different kinds of terreſtrial waters; thoſe, for example, of Springs, Rivers, Lakes, or the Sea. Of thoſe, baths may be had or made of any degree of cold or heat, that is required. I ſhall here onely conſider them, as 1. cold, 2. temperate, 3. tepid or hot; and then add ſome account of the Vapor bath, its uſes and effects.

[a] De Liquid. uſu. [b] De tuenda valetudine. [c] Lib. vi. cap. xxvii. [d] Geograph. lib. xv. [e] Nat. hiſt. lib. xxix. c. 1. lib. xxxi. c. 3. &c.

## I. *Of the Cold Bath.*

§ 432. Whoever would conceive a rational notion of the operation and effects of any medicine, muſt firſt be well acquainted with the ſtructure and uſe of the parts of the body, with the animal oeconomy in general, with the frame and nature of the part in particular, to which it is to be applied, as well as with the quality of the medicine itſelf.

§ 433. The fibres, of which the veſſels and other ſofter ſolids of the animal body are compoſed, are of an elaſtic or ſpringy nature, and ſo exquiſitely ſenſible, that they are every inſtant changing their tone, growing more tenſe or lax, as they come to be affected by the alterations conſtantly wrought in the animal juices, they contain, or in the atmoſphere, that ſurrounds them. Thus, the tone of the fibres of an animal is never at a ſtand; but more variable, than the beſt conſtructed thermometer, in which the liquid is never found at reſt. The brute creation ſenſibly feels the effects, the changes of the atmoſphere produce on them, and diſcovers it to the obſervant: Ruſtics foretel the changes of weather, particularly to wet or dry, by obſervations on the deportment of their cattle and fowl, which are always found to lick and ſmooth their coats, or feather themſelves, at the approach of rain, before any of our arteficial machines can meaſure the change. Theſe creatures feel an itching, or ſome certain ſenſation on the ſkin, upon this alteration of the air, which makes the one lay its fur ſmooth by rubbing or licking it; and the other ſqueeſe, with its beake, a gland in the rump, which ſecerns, and, upon compreſſion, diſcharges an oily or unctuous ſubſtance, with which they beſmear their feathers, ſo as they may be leaſt affected by the impending rains.

§ 434. The whole animal frame is made up of fibres of this kind. Theſe fibres are moſtly vaſcular. The veſſels, they compoſe, are twofold; 1. Arterial; and

and 2. Venal. The 1. or arterial are theſe which carry the maſs of humours from the heart, or center, to the extremities, for the nutrition of the ſeveral parts and the elaboration or ſeparation of other juices, from the general maſs for the uſes of the oeconomy. The 2d. or Venal are thoſe, that carry the ſuperfluous maſs, ſpoiled indeed of all that is neceſſary for the forementioned purpoſes, back again to the heart and lungs, by paſſing through which, it is as it were renewed, repleniſhed with ſubſtances ſimilar to what it before loſſed, which it beſtows in its courſe, as before, upon the ſeveral parts in its paſſage. This is called the Circulation of the blood, the happy diſcovery of our immortal HARVEY.

§ 435. Beſides the very minute tubes, by which the arteries and venes communicate, each have certain other tubes exquiſitely ſmall appertaining to them. Theſe tubular appendages terminate or begin in the ſkin, and conſtitute that innumerable and inconceivable number of perforations of the ſkin, which are called the Pores. Theſe ſubtil ducts are two fold; 1. The arterial or excretory pores, which procede from the arteries; by which a certain ſubtil excrementitious humor, exceding in weight all the other evacuations of the human body, is, in an healthful, which is the natural ſtate, continually diſcharged in an inviſible vapor or exhalation, or in a perceptible dewy moiſture. This is the perſpirable or tranſpirable matter, which is diſtinguiſhed into inſenſible or ſenſible Perſpiration or Tranſpiration; the nature and excretion of which was firſt and beſt explaned by SANCTORIUS, an Italian Phyſician, and further illuſtrated by our great LISTER, and the KEILS.

§ 436. 2. The venal or inſorbent Pores, are ſmall and inviſible ducts, which, paſſing, like the arterial, through the ſkin, communicate with the ſmalleſt capillary branches of the venes, and thus convey to the maſs of blood, all matters that are applied to the ſurface of the ſkin in a ſtate ſubtil enough to paſs their orifices.

orifices. By theſe, various medicines are conveyed into the blood and produce their reſpective effects. By theſe, nouriſhment is abſorbed from the very air: For, by theſe alone we can account for the extraordinary fatneſs of cooks, butchers, and other perſons concerned much in dreſſing or handling of proviſions for food: The effluvia or ſubtil exhalations, that conſtantly fly off ſuch bodies, eſpecially when warmed or heated, enter into theſe pores, and are by them conducted to the venes, and ſo mixed with the blood, and by the circulation, applied to the ſeveral purpoſes of the oeconomy. Hence, we may ſee, that good air is neceſſary to our well being; as well for what we may inſpire or inſorbe by theſe pores, as for what we take in by the Lungs. And hence, we may learn how cautious we ſhould be in the choice of water for external, as well as internal application: For both purpoſes, the lighteſt, ſubtileſt, and ſofteſt water ſhould in general be choſen; except in ſome particular caſes, where that, naturally or arteficially medicated, may be found more effectual and proper.

§ 437. This ſhort ſketch of phyſiology premiſed, the effect and operation of topical or external applications in general, that of water in particular, may be more rationally explaned and eaſily underſtood.

§ 438. The water uſed for cold, as well as temperate and warm, bathing are to be conſidered as pure or ſimple; as that of rain, ſnow, ſweet or inſipid ſprings, &c. or as compound, ſuch as the mineral, or medicated waters. Here, we ſhall confine our ſelves to ſimple water ſolely, leaving the others to be treated of in the ſequel, under their proper heads.

§ 439. By bathing in general, is meaned the immerſion of the whole or ſome particular limb or part of the body in water; though certain dry applications, ſuch as heated air and vapor, as well as ſalt, ſand, &c. have obtained, as before obſerved, the denomination of Baths, in a phyſical, as well as a chemical, acceptation. Here, we mean, by bathing, the immerſion

of the whole or ſome particular limb or part of the body, in a ſimple watery fluid onely, either cold, temperate, warm or hot, or lying in the vapor of ſuch. And firſt of cold bathing.

§ 440. The action of water, upon the body therein immerged, depends, 1. upon the purity or heterogeneity of the water; 2. upon its levity or gravity; whence its fitneſs or unfitneſs to diſſolve matters, or enter the pores of bodies; and, 3. upon the different degrees of its Coldneſs or Heat.

§ 441. 1. The pureſt, ſimpleſt waters are the lighteſt, the moſt ſoft and capable of diſſolving and waſhing of bodies, the moſt ſubtil and fit to enter the pores of the ſkin, and dilute the blood. Theſe waters are found cold or hot, according to the temperament of the air and earth through which they have paſſed, or in which they are kept. The more heterogene the water, the more heavy and groſs in general it is found, the more hard and unfit to diſſolve bodies or enter into the maſs of humors by the pores. Its coldneſs or heat depends upon the ſame accidents with thoſe of the moſt pure; for, in this reſpect, all waters are but paſſive; ſome being more ſuſceptible of heat and cold than others, for reaſons before obſerved.

§ 442. 2. The lighteſt water is found eight hundred times heavier, than common air. In this proportion, then, is the preſſure upon the body immerſed in water increaſed, by the greater or leſſer weight of water incumbent upon the ſurface of the body: This is ſo much added to the weight and preſſure of the atmoſphere, which is ſuſtained alike in, as out of, water.

§ 443. 3. Water is rarefied by heat and condenſed by cold. Hence, cold water is heavier, than the like volume of hot. The colder the water, the more denſe, the more heavy, the more groſs and unfit to diſſolve bodies, and enter the pores of the ſkin, it will always be found.

§ 444. Hence, the action of cold water, upon the body therein immerged, is eaſily conceived: It muſt act,

act, 1. chiefly by its fluidity, which qualifies it to embrace and compreſs equally all the parts; 2. by its coldneſs, which conſtringes the ſolids, and condenſes the fluids; and, 3. by its gravity, which, by compreſſing the ſurface with an additional weight, repels all the fluids from the circumference to the center.

§ 445. As the dimenſions of all the veſſels, expoſed to the immediate action of the cold bath, muſt neceſſarily be ſo contracted, as to receive or contain but very little blood, during the impulſe; ſo, of neceſſity, the great, internal veſſels muſt be proportionably diſtended and enlarged. As ſoon, as this external impulſe is removed, if the bowels, which perform the vital functions be vigorous, the blood is propelled with new energy throughout the oeconomy, by the increaſed force given the elaſticity of the fibres of the containing ſolids. And thus, circulation and tranſpiration, which were both for a while, in ſome meaſure, obſtructed or retarded, are reſumed and carried on with more than ordinary vigor. The body, which, before bathing, was cold and chilly, from a languid circulation and an unequal diſtribution of vital heat and ſpirits, the conſequence of a relaxation of the ſolids, grows warm and lively, perſpires freely; and, if cloſe covered up in bed, will ſweat profuſely; all which ariſe from an extraordinary momentum given the blood, by invigorating and bracing up the tone of the relaxed ſolids.

§ 446. The cures performed by cold bathing are all proofs of the truth of this theory. Whatever diſorders ariſe from a debilitated and relaxed ſtate of the ſolids, which muſt ſooner or later bring on a viſcid, ſizy, ſluggiſh diſpoſition of the blood and juices, if taken in time, before the bowels are affected or obſtructions are formed, may be effectually relieved jointly by this action of the water and this re-action of the animal fibres, in cold bathing.

§ 447. As the primary and principal effect of cold bathing is wrought upon the ſolids, whoſe action upon

the fluids is thereby promoted or altered; conſtant care is to be taken not to adminiſter this remedy, where, by length of time and other accidents, ſuch a change is wrought in the juices, as may make it dangerous to compreſs or forcibly to propel them from one part to another: For, when they are groſs and viſcid, or onely in too great abundance, dangerous obſtructions or inflammations may be formed, or an increaſe of ſizineſs and viſcidity induced. Beſides, the ſolids will be weakened by every effort, they make to contract or conſtringe themſelves, when the contained fluid is, from its quality or quantity, incapable of yielding to the external compreſſure of the ſolids wrought upon by the cold water. And, when the fluids are by any means reduced and broken, or rendered thin, acrid or ſharp, by increaſing the force of the circulation, or diſtending ſome of the internal veſſels, by the ſudden influx of blood, in the lungs, brain or other bowels, an haemorhage, an effuſion of blood, or burſting of blood veſſels, of moſt fatal conſequence, may well be occaſioned, by ill-timed cold bathing.

§ 448. A ſimilar reaſon renders univerſal cold bathing perilous and deſtructive, where any bowel is obſtructed, inflamed or debilitated: The contraction of the fibres and the conſequent diminution of the diameters of thoſe veſſels, which are neareſt the ſurface or moſt affected by the cold immerſion, muſt occaſion a greater impulſe and diſtention of the veſſels more remote from its action; theſe then muſt receive a greater influx of blood in proportion to their ſizes and the tones of their fibres. Such of theſe veſſels, as are by any means obſtructed, muſt have that obſtruction increaſed or confirmed by cold bathing, and ſuch, as are any way debilitated, muſt be proportionably diſtreſſed by yielding more to the increaſed influx thus occaſioned. Theſe general conciſe cautions premiſed, let us procede to conſider in what caſes and circumſtances cold bathing may be uſed with deſired ſucceſs.

§ 449.

§ 449. As the general diſuſe of water is to be univerſally regretted; ſo the great, modern neglect of cold bathing is much to be lamented by all the northern inhabitants of the earth more eſpecially; but chiefly by the inhabitants of theſe northern iſlands in particular, whoſe natural diſeaſes may moſtly be prevented or cured by the rational uſe of cold bathing. But, to illuſtrate by ſome examples;——

§ 450. There is not any diſorder, to which we are more ſubject, than thoſe, that take their riſe from obſtructed or inordinate perſpiration. The diſcharges by the pores of the ſkin are not only greater in quantity, but of more importance to the oeconomy of life, than all the other excretions taken together. The more changeable and uncertain the climate, the more irregular muſt the cutaneous diſcharges always prove. Our climate being extremely variable, obſtructed perſpiration, with all its train of evil conſequences, muſt be, as we find it, very common. Hence, what we call catching of cold becomes ſo frequent. Hence, the Murr or ſtuffing of the Head, Rheums, or Catarrhs, Coughs, Aſtma's, &c. are ſo rife amongſt us.

§ 451. I do not point theſe out, as diſorders, which may be cured by cold bathing. I have already obſerved, that when the juices are in any wiſe morbid, when they offend in quantity or quality, or when any particular part is inflamed, obſtructed or weakened, cold bathing is in general to be avoided. But, the juſt now mentioned conſequences of obſtructed perſpiration may well be prevented by the timely uſe of cold bathing; which gives ſuch a ſenſible elaſticity to the Fibres, as keeps the ſkin proof againſt the frequent, ſudden changes of the weather, whether from hot to cold, from dry to moiſt, or the reverſe; and, by preſerving that due tone, ſupports a free and equal circulation, and with that, the due ſecretions, as well as this and other excretions, neceſſary to perfect health.

§ 452. Rachitis, or Rhachitis, the Rachits, or Rickets, as it is commonly called, is a diſorder, that fo-

regners, ſometime, have looked upon as endemial in Britain, peculiar to our ſoil and climate. But, for this notion, there is no good authority. Some look upon it to be a new diſtemper; for no better reaſon, than its not being expreſly named by the ancients; but, the ſigns and ſymptoms of the diſeaſe ſeem to be given by HIPPOCRATES in ſpeaking of the diſorders of children, where he mentions the bending inward or diſtortion of the ſpine, the preternatural growth of the head, &c. It is beſt treated by the moderns; among which, the moſt eminent are our GLYSSON, SYDENHAM, CHARLTON, and MAYOW. By theſe it is confeſſed, the Rachits ariſe from an unequal diſtribution of the nutricious juices; from the abundance of which, ſome parts of the muſcles, bowels and bones increaſe beyond the natural ſize, to the disfiguration, and diſtortion of the parts, or the diſlocation of the joints; whileſt others, from a defect of the neceſſary ſupplies, emaciate, ſhrivel, and conſume. Though this diſorder be too rife in our country, I ſee no juſt cauſe for pronouncing it endemial. It is not improbable, the humidity of our climates may make it appear more common with us, than in drier countries; but, I doubt, no part of Europe will be found free from it; eſpecially, where ſoftneſs and luxury have broken the natural ſtrength and hardy diſpoſition of parents and their unnatural, but faſhionable, ſubſtitutes, Nurſes. The Rachits were not taken notice of in Britain before the year 1620, or thereabouts, when our GLYSSON obliged the public with his treatiſe on this ſubject. About this time it was, that our Anceſtors began ſenſibly to fall from the primitive ſimplicity of their Diet, Cuſtoms, and Manners. From this period, we may date the riſe, and count the progreſs of this enervating and disfiguring diſtemper. It can not therefore be deemed properly endemial, nor ſolely confined to our ſoil or climate. Our phyſicians having firſt favored the world with a rational and juſt deſcription and method of cure

of

of the diſeaſe, is not ſufficient grounds to charge the diſtemper upon Britain. Happy it were for us, had this been the onely diſtemper, luxury had introduced, and that that fell contagion had not more diſordered and disfigured our minds, than the Rachits have deformed our bodies. But, this is no place for political phyſic.

§ 453. Among the various remedies recommended for the Rachits, cold bathing has been found the chief: It is that, by which this diſorder is moſt effectually prevented, and without which, in mine opinion, it can hardly be perfectly cured: For, the moſt powerful alteratives preſcribed, will be found ineffectual in bracing up the relaxed ſolids to their due tone, without the help of frequent and long continued immerſion in cold water. And the early and frequent uſe of it, will be ſufficient to prevent this deteſtable diſtemper.

§ 454. Sir JOHN FLOYER [a] is of opinion, that the Rickets were not known in England before the original cuſtom of Immerſion was exchanged for ſprinkling in Baptiſm. I ſhall not here enter upon a diſquiſition into the ſoul-ſaving or body-healing nature of immerſion, conſidered as a Sacrament. As a phyſical agent, a ſingle immerſion, ſacramentally or otherwiſe performed, could hardly be ſufficient to prevent or to cure this or any other confirmed diſtemper. But, the changing a very antient civil cuſtom, and an eſtabliſhed religious Ritual, ſo remarkably, as from a general immerſion in cold water, to the ſprinkling of the face ſolely, ſlightly, with that element, ſhews that idle fears were contracted about general immerſion, that men began to drop it in every ſenſe, and therefore had the very form of a Sacrament altered by a Canon, to prevent the dreaded ill effects, even in Baptiſm. It muſt then be owing to a general neglect or diſuſe of cold bathing or waſhing, not ſolely to the

[a] ΨΥΧΡΟΛΟΥΣΙΑ: or Hiſt. of cold bathing.

alteration of the baptiſmal manner of immerſion, that this ſenſible change was obſerved to have aroſe in the conſtitutions of our children about the beginning of the laſt century. It is therefore much to be wiſhed, that the ſalutary regimen may in all reſpects be reſtored. It is to be hoped, that men will inure their children, from their infancy, to cold waſhing and cold bathing, as the moſt powerful preſervative and reſtorative of health and vigour. The advantages of which are recommended by the grave authority of ARISTOTLE[a], who ſays it is not onely neceſſary for the preſervation of health; but alſo makes men hardy and ſtrong, fit for the army.

§ 455. In recent luxations, or ſtrains and bruiſes, the veſſels are ſo weakened by the diſtraction, that they receive too great a flux of humors; whence tumor, pain, &c. enſue. In theſe, there is not a more preſent and effectual remedy, than cold water; which, by its weight and by its cooling, contracting quality, preſſes upon and conſtringes the weakened parts, and prevents the flux of humors uſually attending ſuch injuries; in which, the rational cure conſiſts.

§ 456. In the Rheumatiſm and Gout, when the inflammatory diſpoſition and the morbid ſtate of the humors is corrected, cold bathing is found a moſt ſovereign remedy. I mention theſe together, as two fatal diſtempers, which I look upon to have the greateſt analogy to each other; and which are ſometimes taken, the one, for the other. The Gout is an obſtruction of the ſynovial veſſels, thoſe, that carry and ſecern a ſmooth, ſoft, gelatinous fluid for lubricating the ſeveral articulations or joints of the body, to prevent their heating, eaſe their friction, and facilitate their motion. This is always attended with more or leſs inflammation and pain, and with a ſymptomatic Fever, in proportion to the habit of the body, and the ſenſibility of the joint affected. The parts engaged being membranous and nervous, the pain is for the moſt part extremely exquiſite and ex-

[a] Politic. lib. vii. c. 17.

cruci-

cruciating, and the ſymptoms are extended from the internal to the external parts, with tumor, inflammation and torture. It generally commences in the joints moſt remote from the center of motion, the heart; as in the toes or feet, fingers or hands: And, as the vital powers decline, or the diſorder becomes more inveterate, it makes a greater progreſs towards the center; and by ſeiſing on ſome more noble bowel or vital part, cloſes the tragic ſcene.

§ 457. The cauſe of this diſorder is moſt certainly a too viſcid ſtate of the lymph and other juices, ariſing from indigeſtion, from a too mucilaginous and acid, or aceſcent diet. This is aparent from the ſubjects of the Gout, which are generally men paſſed the meridian of life, thoughtful, inactive and ſedentary; ſuch, as are given up to a luxurious, voluptuous courſe of life; wine, cider, and beer bibers; great eaters, eſpecially of animal and other mucilaginous or gelly-giving food; followers of Venus, or the unfortunate deſcendents of ſuch, who are often attacked earlier in life; in all which, eſpecially during the fit, the blood is found viſcid and ſizy; the urine thick and high colored, with other ſigns of a general viſcidity of the Humors.

§ 458. The moſt rational and effectual methods of preventing and curing the diſtemper are farther proofs of this notion. Such as have none hereditary taint, and are moderate in the uſe of the Non-naturals; eat but ſimple food, chiefly vegetable; drink but milk, or water; lead active lives, without exceſs of Venery; and avoid the extremes of heat and cold in their exerciſes; ſuch men, by keeping up a due fluidity of the juices, by the ſimplicity of their diet, without viſcous and inflaming fermented liquors; and by ſupporting a free circulation, and a due tone of the ſolids, by regular exerciſe; are rarely, if ever, ſeen afflicted with this racking diſtemper, the worſt temporal curſe of opulence and luxury. Thoſe, that are attacked, are ſlowly cured by ſuch a method of living,

ing, as I have deſcribed. In the fit, they are relieved by ſeaſonable blood-letting; by attenuating and reſolving medicines, which are chiefly alcaline or alcaleſcent; adding a ſoftening and diluting diet; by warm bathing and fomenting; in ſhort, by every thing, that breaks the viſcidity of the juices, obtunds or blunts acidity, and reſtores the general maſs of humors to their natural fluid, ſoft and balmy texture, and relaxes the tenſion of the fibres.

§ 459. In perſons, who have the misfortune to inherit or contract this morbid, gouty habit, as ſoon as the ſtronger irritation of the inflamed blood abates, which ſome time kept the ſolids, in the immediately affected parts eſpecially, in a tenſe, criſp ſtate; as the fit declines, the fibres in general are found totally unbraced, quite relaxed; which keeps not onely the patient a long time decrepid, but ſubjects him the ſooner to a new fit; as the relaxation of the fibres greatly contributes to increaſe the preſent, or induce a new viſcidity of the juices. In ſuch like caſes and circumſtances, nothing bids fairer for the reſtoration of ſtrength to the enfeebled parts, and preventing relapſes, than cold bathing, which moſt ſpeedily and effectually braces up the relaxed fibres to their due tone, and reſtores a free and equal circulation of the blood and juices; upon which their neceſſary fluidity, together with the requiſite ſecretions and excretions, depend.

§ 460. The Rheumatiſm ſeems to differ chiefly in its place or ſphere of action from the Gout: Whileſt this principally attacks the joints and their adjoining membranes, that affects the muſcles, membranes, or membranous capſules of the muſcles and tendons, the glands, and even the perioſteum, or membrane, that immediately invelopes or covers the bones; and afflicts with pains exquiſitely acute, but inferior to thoſe of the gout; unleſs when the Perioſteum, or ſome very ſenſible membrane, is engaged. It is ſometimes attended with a fever, which is generally of the ſlow, remittent kind. The pains are not always fixed, or confined

to

to the part firſt attacked; but wander, ſhoot, and fly about, ſometimes with aſtoniſhing ſwiftneſs. The parts affected are often tumified, rarely inflamed outwardly. During the fit, the Patient is ſeiſed with a general languor and imbecility, impatient of being touched, incapable of motion, at leaſt in the limbs affected. This excruciating and enervating diſtemper owes its origine to cauſes ſimilar to thoſe of the gout. In the one, a vitiated ſerous humidity and a flatulency prevail more than in the other. Both require a ſimilar method of prevention and cure. After the fit, the tone of the fibres is generally more relaxed in the Rheumatiſm, than in the Gout; and after due evacuation and preparation, the cold bath produces as happy effects in the one, as in the other. In both, the general relaxation of the fibres is cured, a free circulation is promoted, the natural diſcharges ſupported, and deſired health reſtored and preſerved, by cold bathing.

§ 461. The antients made free with cold bathing, when the morbid ſtate of the juices might ſeem to forbid it: Thus, we find, GALEN uſed it with ſucceſs, not onely in the Ephemera or Day-Fever, ſo called from the fits terminating within the age of the inſect, called the Ephemera, or Day-fly, a natural day; but alſo in Putrid and Hectic Fevers, where there was no Bowel inflamed or obſtructed. I have known Intermittents happily cured by the ſame means. It muſt be confeſſed, it is a violent remedy, and that none, but the young and robuſt can well be ſuppoſed capable of withſtanding the ſhock of a ſudden immerſion in cold water, when the blood is highly heated and rarefied by the febrile motion and the ſolid fibres thereby braced and diſtended. They, that can endure the ſhock, muſt certainly undergo a ſpeedy and extraordinary change: For, the excretions by the Pores, by the urinary Ducts or firſt paſſages muſt in all likelihood be greatly increaſed; any of which may well prove critical; and, in vigorous conſtitutions, ſalutary.

§ 462.

§ 462. However unfit or hazardous cold bathing may appear in feveriſh paroxyſms; it is evident from what has been already ſayed, under the heads of Rheumatiſm and Gout, that after fevers, when the vice of the humors is duly corrected, it muſt effectually reſtore the loſſed tone of the fibres; and by preſerving that tone, prevent all ſorts of fevers, as well as many other diſorders. By this manner of acting of water in fevers, we may conceive how, and for what reaſon, it has for ages been deemed the beſt remedy for that moſt dreadful fever attending the bitings of mad dogs and other enraged animals; which diſtemper is generally moſt fatal, when it is attended with the Hydrophobia or dread of water, by which it is commonly attended. Here, the ſudden and unexpected immerſion in cold water powerfully brings on a ſweat, which is the principal relief in this horrid diſtemper. Where a ſweat is not occaſioned, the cold bath is not found ſo ſerviceable as the warm.

§ 463. If I were to enumerate here, the various diſtempers, in which cold bathing may be uſeful, this would prove rather a courſe of Pathology, than a diſſertation on the uſe of water. Let it ſuffice, that I obſerve in general, that where the preſervation of preſent health depends upon keeping the tone of the fibres and the diſpoſition of the cutaneous pores in due order, or where the reſtoration of loſſed health is to be brought about by recovering the natural tone of the ſolids from a contranatural relaxation of their fibres, or by regulating the diſpoſition of the pores, eſpecially from ſuch a ſtate; cold bathing is the principal, if not the ſole, remedy. For proof of this, let us but conſider the happy effects of this application, known to the moſt rude and ignorant of the human ſpecies.

§ 464. Hiſtorians and Phyſicians are agreed, that in the moſt barbarous ages of theſe northern countries, by which I mean the whole continent of Germany, taking in antient Scythia and the modern governments,

vernments, whether popular or deſpotic, of Sweden, Norway, Denmark, Poland, and Muſcovy, as well as theſe our Iſles; immerſions and waſhings in cold water, from earlieſt infancy to oldeſt age, were the common, conſtant uſage, for a great length of time. The antient Romans went out of their hot, into their cold, baths. Several Indian nations have done and ſtill practiſe the ſame; as do the whole people of Finland, Livonia, and the great, extended empire of Ruſſia; where, after warm bathing, they not onely go into common cold and ſuperficially frozen water, but even roll themſelves in ſnow. The effects by this uſe of cold bathing produced, ſhould ſurely be ſufficient to reſtore and eſtabliſh the uſe of it among us; ſince it is obſervable, that not onely the different nations mentioned, but our brave anceſtors the Britons, were larger and ſtronger, as well as more ſtrait and comely of ſtature, more long-lived, more healthy, more robuſt and vigorous in all reſpects, than we or any other people, who have not come into and do not continue this familiar uſe of cold water, have been found in this or any other age. Many men experience, though too few obſerve, the happy effects of waſhing their limbs and eſpecially their heads in cold water. They are much leſs ſubject to catching cold, to catarrhs or defluxions upon the gums and glands of the mouth and throat; to ſtuffings and runnings of the noſe, and the like. And one effect, of importance enough to demand our utmoſt attention, I apprehend to be owing to the uſe or neglect of waſhing the head in cold water: It is a trite obſervation of the practicioners in chirurgery, in France, and other neighbouring countries, even where the climate is not much hotter than ours, that wounds in the head in general, and often the moſt ſuperficial, are commonly deemed, and found upon experience, mortal; whereas, not onely wounds of the face and hairy ſcalp, but even thoſe of the meninges or membranes, that invelope the brain, yea, even with a loſs of ſubſtance, as well

well as a diviſion or ſeparation of the parts, of the brain itſelf, and that by gun-ſhot wounds, as well as by theſe of cutting weapons, are with us, moſt frequently, happily cured. This, I can not think wholely owing to our colder climate, as the like ſucceſs has attended our chirurgeons in the treatment of our wounded men in different parts of the neighbouring continent. Nor can I attribute it ſolely to the now known and confeſſed ſuperiority of out chirurgeons to thoſe of France and other countries. I muſt therefore rather incline to impute it to this; that the people of the continent of Europe in general, the French in particular, accuſtom themſelves to thick, warm, woollen caps at night, and ſeldom or never bathe or waſh the head in cold water; on the contrary, the later are early taught to look upon the cuſtom, as dangerous and barbarous, and therefore abhor it; whileſt our countrymen wear thin linen or no caps at all at nights, and, as often, as they waſh their faces, waſh or bathe their heads in cold water. In the one then, it may be judged, the veſſels of the head and brain are more relaxed, and receive a greater influx of more heated and rarefied blood, than can be imagined in thoſe, whoſe heads are cooled, and whoſe veſſels are contracted in their diameters, within due bounds, by their cool lying at nights, and frequent affuſion of cold water in the day. This hint, however, I ſubmit to the further enquiry and obſervation of the curious.

§ 465. I ſhall conclude what I have to offer further upon this head, with two practical obſervations of great conſequence, though too little attended to.

§ 466. The one is with regard to obſtructions of the urinary paſſages, called Iſchuria, the ſuppreſſion or unnatural retention of urine. This tormenting diſeaſe ariſes from various different cauſes, which may be better conceived by conſidering the nature of this excrement and the texture of the parts, by which it is ſecerned and excreted.

§ 467.

§ 467. The Urine is a liquid excrement, conſiſting of a conſiderable quantity of ſimple aqueous humidity, charged with ſuch heterogeneous parts, as are hurtful to the animal oeconomy. In this, the blood gets ſhut of ſuperabundant ſaline, oily and terrene parts. It is called Lotium, the waſh or ley; for, ſuch it proves to the blood, when it frees it from ſuch impurities, as it is capable of diſſolving. Hence, the ſigns of the different diſpoſitions of the maſs of humors, upon which health or ſickneſs depend, are collected from the appearance and contents of the urine; which, in a morbid ſtate, is found to contain a redundance of ſalt, of oily or earthy matters, or of one or all of them; when, in the natural, healthful ſtate, it is compoſed of juſt proportions of the three, with water enough to diſſolve them, ſo as to carry them off with moſt eaſe and ſafety to the oeconomy.

§ 468. This excrementitious liquor is by a contrivance of ineffable wiſdom ſeparated in the glands, called the Kidnies, from the maſs of blood, by ſuch ſubtil, fine ſtrainers, as do not admit a ſingle red globule of blood, nor any quantity of the ſerum to paſs their ſlender tubes, when the thickeſt and fouleſt urine gets a free paſſage.

§ 469. The extreme orifices of theſe ſmall tubes open and diſcharge their contents into one common receptacle in each kidney; which, from a funnel-formed head, runs, by ſeveral ſmaller canals, into a fine, ſlender, pliant, cylindrical tube, called, the Ureter, and is continued till it opens into the bladder, one on either ſide, near its neck.

§ 470. The Bladder is a cyſtis or bag of a figure nearly oval, or pair-formed; ſeated in the inferior part of the belly of all ſuch animals, as make urine, with its bottom uppermoſt, and its mouth or orifice downwards, eſpecially in man; in adult perſons, it is ordinarily capable of containing about a pint of liquor. It conſiſts of three different membranes or tunics, to which ſome add a fourth. The firſt or outward mem-

brane is a covering, which it borrows from the membrane, that lines the lower belly, called, the Peritonaeum, which extends commonly no farther than the bottom or ſuperior part of the bladder. Betwixt this and the inner, or as ſome call it, the ſecond or middle coat, a cellular membrane is found, often full of fat, which is what ſome look upon, as the fourth tunic. The ſecond or inner coat conſiſts of muſcular fibres diſperſed in different directions, but chiefly tranſverſe and longitudinal. Under this, is the internal, innermoſt or third coat, whoſe inward ſurface is covered with a ſoft mucous or gellatinous ſubſtance, to ſoften and guard this receptacle from being injured or irritated by the urine. The neck of the bladder is furniſhed with a membranous canal of a cylindrical form, guarded with ſuch a mucous liquor, as the bladder itſelf: This tube, called, the Urethra, is about the thickneſs or diameter of an ordinary gooſe quil, and of different lengths in both ſexes; in which it is in common deſtined to diſcharge the urine, but in the male alſo to ſerve in procreation. The neck of the bladder is alſo provided with a muſcle, called, the Sphincter; whoſe fibres make a band, that embraces and cloſes the orifice; ſo that none urine can paſs, till its conſtriction be by ſome means relaxed.

§ 471. From this ſhort, rough ſketch of the anatomy and uſe of the parts, that ſecern, contain and diſcharge the Urine, together with the notion given of that excrement, it can not be difficult to conceive how obſtructions or ſuppreſſions of urine are cauſed. Theſe may be occaſioned by vices of the humors or of the parts; as when the urine is charged with ſharp ſalts, irritations and inflammations of the parts, attended with ſtrangury or iſchury, are brought on; when it is charged with mucous and terrene parts, tartarous or calculous concretions, the Gravel or Stone, in the kidnies or bladder, are produced; which can eaſily obſtruct the paſſage of the urine through any of the

tubes.

tubes. But, theſe are not of the kinds of ſuppreſſion of urine, that may properly be relieved, by the external application of water, eſpecially of cold. They are only ſuch, as ariſe from the vices of the ſolid or containing parts; theſe are chiefly from a too great or hard conſtricture of the fibres, eſpecially of the Sphincter; together with a relaxation of the integuments or a diſtention of the muſcular and other coates of the bladder, beyond the power of performing the contraction of their fibres, neceſſary to overcome the ſtricture of the Sphincter and propel the urine.

§ 472. In theſe caſes, which frequently happen, and eſpecially in the later, the common ſtimulating, diuretic, or urine-forcing medicines, which are but too often injudiciouſly adminiſtered, muſt prove dangerous, injurious and deſtructive, as they are generally found upon experience: Such can but irritate; and irritation is more likely to increaſe, than cure or abate the diſtreſsful malady. In the one, warm bathing, which ſoftens and relaxes the overbraced fibres of the retaining muſcles, or of the tubes or membranes of the kidnies, bladder and urethra, is generally neceſſary, with other helps, which are hardly ever found ſafe without it; whereas this often proves by itſelf a ſufficient and effectual remedy. In the other, cold bathing, which alone beſt reſtores to the fibres and membranes of the over-relaxed or diſtended urinary canals and common receptacle their contractile power, which is alſo helped by the preſſure of the water, and the conſtricture of the fibres of the outward integuments and muſcles of the lower belly, which it occaſions; is the moſt ſpeedy and certain relief. I have often ſeen very old perſons, who are moſt ſubject to this kind of retention of urine, and infants, tortured almoſt to death with diuretic and diluting medicines and ſtoved and ſweated to diſtraction, by the preſcription of ignorant or miſtaken practitioners; when a ſimple, ſingle immerſion in cold water, or even the ſudden expoſing the patient to the cold air, has procured immediate relief

by a copious diſcharge of long retained, and by injudicious treatment, heated, ſharpened and increaſed urine. In theſe caſes, therefore, I recommend, preferable to all other medicines, the expoſing the body ſuddenly to the cold air, giving cold water to drink, and bathing firſt the extremities, and after that, if it ſhould be neceſſary, frequently immerging the whole body in cold water, which generally brings the deſired relief moſt ſpeedily.

§ 473. As immerſion in cold water, by helping the over-diſtended and over-relaxed parts to contract, ſo as to promote the natural diſcharge of urine thus too long retained or ſuppreſſed; ſo it effectually cures that flaccid, relaxed ſtate of the fibres often ſeen in old age and infancy, which cauſes a conſtant or frequent and involuntary emiſſion of urine.

§ 474. I cannot cloſe this obſervation, without cautioning every body againſt the pernicious cuſtom of forcibly retaining and ſuppreſſing their urine, againſt repeted calls of nature; by which a total and obſtinate ſuppreſſion has been often fatally induced. This complaint when induced by long-forced, unſeaſonable retention, often the fruit of miſtaken modeſty, is ſometimes tedious and difficult of cure. It generally yields to the ſame means, that relieve ſuppreſſion from a relaxation.

§ 475. The other and the laſt practical obſervation, which I ſhall offer under this head, relates to the firſt, the greateſt, nobleſt and moſt important worldly taſk, ſet by the almighty Creator to his creatures, Generation or Procreation.—Increaſe and multiply was heaven's firſt command to man. A precept conſtantly enforced by the voice of nature and reaſon; yet, though diligently obſerved, it frequently proves fruitleſs in ſome, from certain imbecilities in either ſex, which may be relieved by the uſe of ſimple water.

§ 476. Men often prove incapable of procreation from a ſoftneſs and too relaxed a ſtate of the fibres.

For

For this, they too frequently have recourſe to rich nouriſhing diet and warm and ſtimulating medicines, which at beſt, give but momentary help, and often increaſe the malady. Whereas, a plane and more ſlender diet, due evacuation, cold bathing, and regular exerciſe, would more effectually enable them to perform the procreative functions, and make them the fathers of an healthful and vigorous progeny.

§ 477. Women likewiſe ſuffer on the other hand from a too delicate, ſoft and relaxed ſtate of the fibres, which, by deſtroying the retentive faculty, impedes and prevents conception, or expoſes them to the loſs and peril of frequent abortions. For ſuch conſtitutions, there is not a more ſafe and effectual remedy, than cold bathing. This ſhould be uſed before, and continued for about two or three months after conception; bleeding and other proper preparations premiſed. And by this means alone, many women may be brought to be fruitful mothers, who either never conceived at all, or having conceived, never brought forth a living child.

§ 478. One of the many evil conſequences of a relaxed and debilitated ſtate of the fibres is a diſcharge of mucous matter from the urethra in men, which is heightened, by certain infection, to a degree of virulence, beyond the reach of cold bathing; from the womb or vagina in women, in whom it is called, Fluor Albus, the Whites. In both theſe caſes, when ſimple, not at all complicated with any thing more than what merely ariſes from a relaxation of the parts, cold bathing is found a moſt ſpeedy and effectual remedy.

§ 479. It remanes, that we add ſome directions for the uſe of, and proper preparations for, cold bathing, and point out the fit times, ſeaſons and manner of applying it.

§ 480. They who accuſtom their children, from earlieſt infancy, to frequent immerſion or waſhing in cold water, will have the comfort of ſeeing them

grow up vigorous and healthful; and they, who obſerve in themſelves the great benefits accruing from this ſalutary uſe of cold water, beſides the pleaſure it affords, when thus made familiar, will be induced to continue the uſe and benefit of it to the laſt ſtages of life. Such will be found to eſcape rickets, coughs, rheums, rheumatiſms, and the lamentable train of evils, that attends thoſe, who, by too great tenderneſs and warmth in their youth, are rendered feeble and enervate, decrepid and old, before half their glaſs is run. They, who are thus early inured to the uſe of water, require no previous preparation, no particular regard to ſeaſons. They waſh in hot and cold ſeaſons alike, and reap the pleaſure and emolument. I know a gentleman not far from eighty years of age, who, early in life, launched out in trade, and continues it with great vigor, profit and reputation. For many years, this gentleman has accuſtomed himſelf to a ſingular kind of cold bath: He ſits or ſtands naked, while a ſervant wraps him up in a ſheet dipped in cold water. And continues in this ſome twenty or thirty minutes every morning winter and ſummer; and in return, enjoys the moſt uninterrupted ſtate of health.

§ 481. But, ſuch as have not been early or long accuſtomed to this familiar uſe of water, muſt have recourſe to it with caution.

§ 482. 1. Care muſt be taken, that the bowels be free and ſound; void of obſtruction, inflammation, or exulceration.

§ 483. 2. That there be not too great a fulneſs, in the firſt or ſecond paſſages. In either of which caſes, proper evacuation, by bleeding, vomiting or purging, as the exigency of the caſe, and the circumſtances of the patient, may require, ſhould precede the uſe of cold bathing.

§ 484. 3. The times for bathing are when the ſtomach and inteſtinal channel and the bladder are moſt empty;

empty; as in a morning, ſoon after the natural diſcharges are made.

§ 485. 4. The propereſt ſeaſon for cold bathing in general, I take to be the colder ſeaſons, not the hot, which are too frequently recommended. Its effects depend upon the conſtitution of the patient. It warms the ſanguine and robuſt, and in ſuch, promotes perſpiration. The phlegmatic and weak, it cools, and obſtructs their perſpiration[a]. But, in ſuch very delicate conſtitutions, as cannot bear the ſhock of extreme cold, care is to be taken to attemperate the coldneſs of the water to their particular caſe and conſtitution; or, after beginning in the warmer weather, continue the bathing to, or through the cold ſeaſon, as the nature and neceſſity of the caſe may require.

§ 486. 5. No perſon is to ſtay in the cold water till it benumbs or thoroughly chills him. And, as cold bathing is in general intended as a ſtrengthener, the water by its coldneſs and preſſure bringing on an univerſal contraction of the ſolids; this intention muſt be fruſtrated by tarrying long in the water; for, then it becomes capable of reſolving and relaxing theſe fibres, which it is employed to brace up and ſtrengthen.

§ 487. 6. Cold, as well as hot bathing, is beſt adminiſtered in a diſcumbent poſture, as that in which all parts of the body are leſt in motion, or moſt at reſt: For, then the action of the water is moſt equal and univerſal; always obſerving that the head be not the laſt part immerged.

§ 488. The tender and delicate ſhould be forbidden to move or ſpeak much, whileſt they remane in the water; becauſe moving the organs of breathing or ſpeech, or any of the limbs, whileſt under the additional preſſure of the water, may greatly diſtreſs and injure feeble parts. Thoſe, whoſe limbs or fingers are apt to be contracted, ſtiffened or be-

[a] SANCTORIUS de aere et aquis, Aph. I. Aer frigidus et lavacra frigida corpora robuſta calefaciunt, eaque, auferendo ſuperfluum, reddunt leviora. Debilia refrigerant, eaque, vincendo calorem, ponderoſiora efficiunt.

numbed by the cold bath, ſhould not perſevere in the uſe of it.

§ 489. Then the coldneſs of the water may be occaſionally increaſed at any time by the addition of divers ſalts, which ſerve at the ſame time to increaſe its weight and preſſure.

§ 490. All volatile alcaline ſalts increaſe the cold of water; whereas the fixed alcalies cauſe the contrary effect.

§ 491. The vitriolic ſalts ſlightly increaſe the cold of water, alum a little more, borax, more than alum, common ſalt more than borax, common nitre more than ſalt, and ſalt ammoniac moſt of all.

§ 492. The proportions, the chief of theſe bear to one another, as ſet down by M. Van MUSSCHENBROEK *, ſtand thus;

§ 493. 1. Roch alum powdered, two drachms added to two ounces of water, each of the degrees of heat of 44 by the Thermometer } cauſed no ſenſible change upon mixture, but in about half an hour fell to $43\frac{1}{2}$.

§ 494. 2. Borax dried and powdered, two drachms added to one ounce and half of water, each of 45 deg. of heat } mixed cauſed a ſenſible change by falling to 43.

§ 495. 3. Sea ſalt dried and water of the ſame temperament and in like quantity } fell from 45 to 41 upon mixture.

§ 496. 4. Common nitre or ſalt peter, in like proportion and of the ſame temperament, } ſenſibly changed as the niter diſſolved, till it fell from 45 to 31.

§ 497. 5. Salt ammoniac and water in like proportions and of the ſame temperament } fell from 45 to 27.

§ 498. Thus may cold baths be medicated, their coldneſs, and with that, their weight and preſſure increaſed, and other qualities changed according to the intentions of the judicious phyſician.

* In Addit. Tranſlat. Act. Acad. del Cimento.

§ 497. The

§ 499. The vitriols, which are metals, chiefly iron and copper, diſſolved in the univerſal acid, and verdigriſe, which is copper corroded by a vegetable fermented acid; all increaſe, in ſome degree, the coldneſs of water upon mixture. But, we muſt take care to avoid the common error of imagining, that waters impregnated with theſe or any other ſalts, are always to be found cold in proportion to the degree of ſaturation: For, theſe and all ſuch like ſolutions muſt come to the temperature of the atmoſphere, or veſſel, in which they ſtand. So that, though the cold of water be ſenſibly increaſed upon adding theſe ſalts till they be diſſolved; yet, the coldneſs ſenſibly decreaſes, in proportion to the warmth of the air, as ſoon as the ſolution is completed; after which, the heat or cold of the water will depend upon other accidents, as before obſerved.

§ 500. The judicious will alſo be cautious in the uſe of waters, thus diverſly impregnated; as their effects upon the ſolids and fluids muſt be very different from that of ſimple water.

## II. *Of Temperate, Warm and Hot Baths.*

§. 501. The antients, whoſe experience taught them the uſes and virtues of baths in general, were moſt exact in the diviſions and diſtinctions of them, as well as in the manner of uſing them. In a regular well conſtituted bath, there were all the conveniencies for ſoftening and cleanſing the ſkin and its pores, by ſweating; by hot and cold immerſion, waſhing and bathing; by inunction, friction, &c.

§ 502. An antient bath conſiſted of four principal parts, by ſome called the houſes or chambers.

§ 503. 1. The firſt was a kind of ſtove, known to the Greeks by the names of ὑπόκαυσον, Hypocauſton, προμαλακτήριον, Promalacterion, to the Latins, by the appellations of Laconicum, and Aſſa*. This

* CELS. & CICER.

was compoſed of three cloſe chambers, of convenient ſizes, contiguous to each other, all brought to different degrees of heat, by means of ſtoves properly placed. In the firſt of theſe, the air was but temperately warmed; in the ſecond, it was rendered tepid, or more warm; and in the third, it was heated.

§ 504. Through theſe ſtoves, or ſome one or more of them, every perſon went into the warm, humid bath, without ſuffering the violent ſhock, that muſt attend going from cold air into warm water, which appears or feels hot, in proportion as the body is before cooled. Here, the change was gradual, inſenſible and agreeable to the whole oeconomy. In theſe ſtoves, the body was by ſlow and almoſt imperceptable degrees warmed; the humours liquified; the pores and ducts rendered free and open; and perſpiration promoted to the wiſhed for point.

§ 505. 2. The ſecond was contiguous to the firſt and compoſed of a chamber of a convenient ſize, in which were three large ciſterns of water of different degrees of heat. The firſt, of a blood warmth, the ſecond, warmer, and the third, as hot as could be borne. This was called, by the Greeks, ἀποδυτήριον, Apodyterion, and περιαλήριον, Periaterion; by the Latins, Tepidarium, and Calidarium; though theſe appellations were by ſome beſtowed on the firſt part of the bath, where the bathers undreſſed. Into one or other of theſe, the patient was conducted from one or other of the ſtoves, as the nature of his caſe and circumſtances directed. For this, the ſtove was juſtly looked upon as a proper, the true preparatory. In this, the hardened, contracted or rigid fibres were ſoftened and relaxed; the humours diluted and molified; obſtructions reſolved, pores and other paſſages opened; pains and rigors aſſuaged; and reſt procured.

§ 506. Care

§ 506. Care was taken, that the ciſterns or baths were large enough, not onely to contain a body in the proper poſture at eaſe, but to admit it to move with freedom: For, though almoſt all motion, eſpecially that of the cheſt and lungs were prohibited, to the tender and weak eſpecially; yet, it was rationally judged expedient, they ſhould not be cramped for room, nor in the quantity of water, on which much depends in many caſes. The public baths were made large enough to take in numbers at once.

§ 507. 3. The third part of the antient complete bath was another chamber conſtructed like the ſecond, contiguous thereto, and furniſhed, like that, with three ciſterns or baths, containing ſeverally, water of different temperatures. The firſt contained water moderately warm, the ſecond, tepid, or ſlightly warm, and the third cold water. This was called, Frigidarium, the cooler, or cold bath.

§ 508. Thus did the antients furniſh themſelves with means to alter their habits of body, by air of different degrees of heat, by water of different degrees of heat, and of cold. They prepared their patient for the degree of warmth in the water, they judged neceſſary for his health, by an appropriate degree of heat in the Hypocauſton or Stove; and as the tranſition from the cold air, to hot water was rendered eaſy, familiar and agreeable, by the different degrees of heat in the ſtoves firſt, and then in the Tepidarium and Calidarium; ſo the ſhock to be dreaded from the admiſſion of cold air upon a body juſt come out of an hot bath, was effectually obviated, by the third part of the bath, the Frigidarium or cooler; where the patient was gradually cooled, in two baths, the one cooler than the other, before he was immerged in the cold bath, which was calculated to brace up the relaxed fibres, to conſtringe the pores to their natural diameters, and to concentrate and retain the native and acquired heat. By which, catching cold and all ſuch like accidents muſt have been happily prevented.

§ 509.

§ 509. 4. Finally, the fourth part of the antient Bath was the dreſſing chamber. This lay contiguous to the ſecond and third. It was a cloſe, convenient room, in which the Bathers were dried and cleanſed, had their ſkins ſcraped and rubbed, with proper ſcrapers, fleſh-bruſhes, and coarſe woollen cloaths, and anointed with fit oils or unguents, to keep the ſkin ſoft and prevent the waſte of ſtrength by exceſſive tranſpiration. After which they dreſſed themſelves in it.

§ 510. Thus, were the antient greeks and romans provided with the moſt ſimple, eaſy, natural, and agreeable method of preſerving preſent and re-eſtabliſhing loſſed health, by the different management and application of that moſt noble, but, with us, deſpiſed and neglected, remedy; common water. And whoever conſiders, beſides the neatneſs and elegancy of keeping the ſkin ſweet and clean, the great neceſſity of keeping up thoſe great and moſt importtant diſcharges, that muſt conſtantly, in an healthful ſtate, tranſpire by the pores of the ſkin, the ſuppreſſion or obſtruction of which lays a foundation for the worſt diſeaſes incident to man; muſt lament the ſhameful diſuſe of bathing, hot and cold, that prevales in our days.

§ 511. Though the antients were thus wiſely furniſhed with the neceſſary variety of baths under one roof; we are not to ſuſpect, that every patient was obliged to go through a courſe of all the ſtoves and all the baths at once: No; they were calculated for the variety of caſes, conſtitutions, and different ſeaſons of the year, that occur; and the patients, accordding to their reſpective circumſtances, were directed to uſe the one or the other, as it proved moſt expedient and requiſite. Thus, cold and phlegmatic habits were deſtined to the hot ſtove chiefly; and occaſionally, to the hot bath; dry and hot temperaments, to the tepid ſtove and warm bath; the ſoft and lax fibre to the cold bath, and ſo forth: For, as the ſtoves heated and dried in different degrees, they could onely

onely be ſerviceable in thoſe caſes, where heating and drying were the curative indications. Thus, they became fit for the cold and phlegmatic habit, in anaſarcous, oedematous and hydropic caſes; whileſt they became improper for the hot and dry temperament, whether in a natural, healthful, or in a morbid ſtate, where moiſtening and ſoftening were the onely indications: For theſe like conſtitutions, the ſecond part of the bath, and likewiſe the third were moſt proper; whileſt they muſt have been totally unfit for cold and moiſt habits. But, the fourth part was more or leſs neceſſary to all, that required any of the others, either for cleanſing, rubbing or anointing the ſkin, or for dreſſing in.

§ 512. The wiſe practitioners among the antients cautioned all that were to uſe any of theſe baths againſt the raſh and indiſcriminate application of them. They ſtrictly forbad them to all plethoric, groſs or full perſons, before due evacuations. Becauſe, the rarefaction of the redundant juices by heat, dry or moiſt, and the ſudden and violent impulſes made upon them by the cold bath were alike dangerous and deſtructive; till the fulneſs was by proper means abated and the humors had full ſcope to circulate freely allowed them. They were alſo forbidden to go into the Baths with their ſtomachs or lower inteſtines charged with food or excrements; leaſt crudities might be impelled from the firſt into the ſecond paſſages, and thereby obſtructions or inflammations formed. Perſons with weak or obſtructed bowels were alſo prohibited the uſe of baths; leaſt a flux of humors might be invited or propelled to the debilitated bowel, by the hot or the cold bath. And for the like reaſon, that perſons uſing the cold bath were directed to immerge the head, with or before the reſt of the body; ſo, thoſe, who were to uſe the warm bath, were cautioned not to dip the head in the warm water; for fear of over-heating, relaxing or repleniſhing the brain: For, omitting to immerge the head

head with the body, in the cold bath, or immerging it in the hot, muſt alike ſubject it to an influx of humors, which, in moſt caſes, may prove detrimental, if not deſtructive.

§ 513. As the cold bath may be medicated with various minerals, ſo may the hot be impregnated with an infinite variety of bodies from the mineral and vegetable creations. Thoſe, medicated with minerals, are either natural or arteficial. The natural hot baths are called Thermae, and are either ſimple or medicated. The ſimple are ſuch as conſiſt of pure water, whether meteoric or terreſtrial, heated in its paſſage through the earth. Of this kind, are the Baths of Pfeffer, Schwaldsbadt, Toeplitz or Toepliz, in Germany, Schlangenbaden and Hirſchbergen in Sileſia, and divers others, which equal the pureſt rain water in levity and ſimplicity, and whoſe extraordinary virtues are onely to be aſcribed to the purity of the waters, &c. The medicated natural Baths are ſuch as are charged with ſalts of different kinds, with ſulphur, with earths, with metals, and other minerals. As the waters of Bath and Briſtol, in Somerſetſhire, of Aken or Aix la chapelle, of Borſet, and Chaud-fontaine, in Germany, of the Caroline Baths, in Hungary, and others, of which apart, in their proper places.

§ 514. The arteficial medicated Baths are ſuch, as are charged by art with various ſalts, ſulphur, &c. according to the intention of the preſcriber. Baths, medicated with vegetables, are always arteficial. Of theſe, there may be an extreme variety of different intentions; as emollient or relaxing, tonic or aſtringent, &c. All warm baths may and ſhould be rendered grateful to the patient by the addition of ſome aromatic plant, flower, ſeed, or other vegetable ſubſtance, appropriate to the caſe; though the great ſtreſs is to be layed on the ſimple water alone, to which I ſhall confine what I have further to offer on the uſe of warm water topically applied, in the relief of internal, as well as external diſorders.

§ 515.

§ 515. In order to judge the better of the uſes and efficacy of warm baths in the relief of various diſtempers, incident to mankind, let us firſt conſider the mechanical operation of water upon the animal ſolids and fluids, agreeable to the nature and properties of ſimple water, as before layed down.

§ 516. We have already endeavored to explane the operation of cold water; part of which is to be taken into the eſtimate of the action of warm; to wit, its gravity; though this be decreaſed ſenſibly, volume for volume conſidered, in proportion as the water recedes from cold to hot. The other qualities, in which the effects of warm water are different from thoſe of cold, ariſe by accident from the heat, which produces a contrary effect from cold.

§ 517. It has been already obſerved, that ſolid and fluid bodies are condenſed by cold, and expanded and rarefied by heat. Hence, the animal fibres, which upon immerſion in cold water, are conſtringed and contracted; in warm water, are ſoftened and relaxed. And the animal juices or fluids, which are condenſed and propelled from the circumference towards the center, in cold bathing, are rarefied in proportion to the heat, invited from the center to the circumference, where the veſſels, by being relaxed, have their diameters enlarged, and therefore more readily yield to the influx and rarefaction of the humors. The mean while, the pores are freed from all foulneſs, ſoluble, or capable of dilution in pure water; which the natural diſcharges by theſe ducts are. And, by the rarefaction of the blood and the extraordinary dilatation of the heart and the blood veſſels, the pulſe is raiſed, the circulation becomes more vigorous, the heat conſequently increaſed, the ſurface of the body grows red, and the pores of the ſkin diſcharge their contents, with freedom and eaſe.

§ 518. To this, add the gravity of the water, with the extreme ſubtility or tenuity of its parts, and

it will be eaſy to conceive what effects it muſt produce upon an animal body immerged or bathed therein. The blood, more than ordinary, heated from without, may be ſuppoſed moſt powerfully invited towards the parts moſt heated and relaxed. But then, the preſſure of the water, which is calculated by geometricians to be eight hundered times heavier than air, balances, in ſome meaſure, the rarefying power, and forces the blood back again towards the center, that is, into the great bowels and veſſels, whileſt it dilutes the whole maſs, by the intromiſſion of ſome of its ſubtileſt parts by the inſorbent pores. Hence, the inteſtine motion of the conſtituent parts of the blood is conſiderably increaſed, by which its viſſidity is broken and reſolved; obſtructions in general, from that cauſe, are removed, and the ſecretions and excretions properly promoted.

§ 519. From theſe mechanical and demonſtrable effects of warm water, by its heat expanding the ſolids and rarefying the juices, by its gravity compreſſing the external veſſels, and thereby forcing the blood, in them heated and rarefied, into the heart, lungs, brain and other bowels, or into the larger internal veſſels; the evils produced by too hot, and the general unadviſed or ill-judged uſe of warm baths, are eaſily accounted for, and from them, judicious, practical inferences and cautions may be drawn.

§ 520. There is nothing of greater importance to the patient, for whom warm bathing is found proper, nor in which the honor of the preſcriber of this bathing is more concerned, than the aſcertaining the fit times and ſeaſons, the regulating and preparing the ſtate and temperament of the body, for bathing; the determining the kind of bath, and its temperature preciſely, together with the ſpace of time neceſſary for tarrying in the bath, with due accuracy.

§ 521. Without the ſtricteſt obſervance of theſe cautions, miſchiefs infinite muſt enſue. Thus, we find

find unfit ſubjects, or the beſt prepared, upon going into ill-regulated baths, or tarrying too long in them, attacked with head-aches, even to a frenzy; with anxiety and palpitation of the heart, with faintings and ſwoonings, &c. Theſe complaints, or ſome of them, are always likely to attend ſoft, delicate conſtitutions, with relaxed fibres; eſpecially, if the bath be too hot. Such as are ſanguine and groſs, with the inteſtines and other bowels full, muſt be liable to obſtructions, inflammations, fevers, continual or intermittent, with variety of other diſorders depending upon the particular circumſtances of the health and habit of body, upon the ſeaſons of the year and the nature and temperature of the water. The more compound the water is, eſpecially with aſtringent, ſtyptic or abſorbent matters, ſuch as alum, vitriols or earths, which conſtringe, coſtipate or clogg the pores; the more ſubject will the patients be to fevers. An obſervation, which ſhould make men moſt cautious in the uſe of baths, whoſe waters are loaded with any of theſe mineral matters; as the Caroline baths in Hungary, ours in Somerſetſhire, thoſe of Borſet near Aken, and the like.

§ 522. Hence, every judicious perſon will with me conclude, that the ſofteſt, lighteſt, pureſt water, as it is the beſt for all the purpoſes of the oeconomy of life; ſo is it alſo preferable to all others for warm baths; except, where the additional force of a ſubtil, mineral ſpirit, of ſubtiliſed ſulphur or its elements, or ſome alcaline or other reſolvent and deterſive ſalt, ſuch as are found in the natural Thermae, or may be occaſionally added in factitious baths, may be judged expedient for particular purpoſes and in extraordinary emergencies: For, whatſoever is found capable of obſtructing the firſt and great intention of warm bathing, ſoftening and relaxing the fibres in general, particularly thoſe of the ſkin and its pores, which are cleanſed and opened thereby, and prepared

to

to yield their contents by ſweat and tranſpiration; whatever, I ſay, is found repugnant to theſe intentions, renders warm bathing of none effect, if not perilous. This is eaſily conceived, upon conſidering ſome of the infinite variety of evils, that neceſſarily attend the obſtructing the pores at any time and in any manner; eſpecially, at ſuch times, as the blood is greatly heated. Thus, the common diaphoretic or ſweating medicines prove injurious and often deſtructive, by their heating the blood, when the pores are not diſpoſed to open and yield their contents. Hot or warm bathing muſt heat and rarefy the juices, as well as expand the ſolids. The pores muſt at this time be greatly diſtended or relaxed; and conſequently, if the water be charged with aſtringent, drying, terrene bodies, the pores may be ſo clogged and obſtructed therewith, as to counteract the warming and ſoftening quality of the bath, and thereby prove of extreme evil conſequences.

§ 523. Though bathing may, at firſt ſight, be looked upon, as in ſtrictneſs it is, a topical application; yet, as no topical medicine can be ſo circumſcribed in its operation, as to affect the outward parts, to which it is immediately applied, onely; ſo none outward application more ſenſibly affects the internal parts, even the univerſal frame, than warm bathing. And when we come to conſider the vaſt variety of internal, as well as external maladies, for which this moſt ſimple, yet powerful application, has been found an approved remedy, from the earlieſt ages of the healing art; we ſhall find, that all our modern boaſted improvements in anatomy and phyſiology, and in the mechanical accounting for the operations of medicines, will appear in judgment againſt us, and reproach us for our ſhameful neglect of one of the moſt effectual remedies, with which bountiful nature or human art has furniſhed indigent mortals.

§ 524. The

§ 524. The general eſtimation and uſes of warm water, among the antients, may be conceived from the authority of the GREAT FATHER of the medical art; who in his aphoriſms tells us, that warm water ſoftens the ſkin, attenuates the humors, aſſuages pain, mitigates rigors or contractions, convulſions and diſtenſions of the nerves, or contractions of the tendons, and cures diſorders of the head [a].

§ 525. This grave authority is followed by that of ARISTOTEL, VITRUVIUS, PLINIUS, CARDANUS, GALEN, ARETAEUS, TRALLIANUS, CELSUS, PLATERUS, PR. ALPINUS and many others, to which the great HOFFMAN [b] adds no ſmall weight. Beſides, every man of ſenſe and judgment approves it; yet, to our hardly delible reproach, the jokes of the ignorant vulgar, who deſpiſe every thing common or known, and who are to be fed upon ſecrets and myſteries; or the idle ſneers of an humorous ſatyriſt, are enough to exclude it the book of modes, and of courſe, to caſt it totally out of practice.

§ 526. Let it be mine ungrateful taſk to ſtem this torrent, and ſtrive to oppoſe ſuch of the potent living practicioners, as have run into this ſhameful neglect of the beſt of remedies, with common reaſon, not the farcical faſhion, that has long disfigured the fair face of phyſic. In this unequal conteſt, I ſhall be allowed to take to my ſeconds ſome of thoſe illuſtrious dead, whoſe works have made them immortal, however their precepts and example, in this inſtance, come to be neglected in our days.

§ 527. From the mollifying and relaxing power of warm water, mentioned in the late cited aphoriſm, together with its quality of diluting, attenuating, and rarefying the juices; its extraordinary efficacy in aſſuaging the pains of inflammations, in reſolving and

[a] Calidum, ſeu Therma, cutim emollit, attenuat, dolores tollit, rigores, convulſiones, nervorum diſtentiones mitigat, capitis gravitatem ſolvit, &c. HIPPOCRAT. ſect. v. aphor. 22.

[b] De balneor. aquæ dulcis uſu in affect. internis.

relieving diſtentions, contractions, ſpaſms and convulſions, in warming and invigorating cold, emaciated and paralytic limbs, is derived.

§ 528. Many and innumerable are the ſervices, that warm water, outwardly applied, may effect in various diſorders and diſtreſſes of the human body.

§ 529. In hard and difficult child-bearing labors, where from the extraordinary ſize of the infant or the inordinate conſtriction or rigidity of the parts, when men have recourſe to the moſt violent meaſures, ſuch as threaten the deſtruction of both infant and mother; warm bathing might ſo ſoften and relax the fibres, as to bring the moſt ſpeedy relief to both. Had due regard been payed to this moſt ſafe and rational practice, there would be leſs occaſion for horrible inſtruments, or the herculean ſtrength, now aſſerted to be neceſſary, and there would be fewer dreadful diſaſters, than we daily ſee or hear of, in the modern maſculine practice of midwifery.

§ 530. The like eaſy ſuccor might be afforded in the ſuppreſſion of urine, or in that of the menſtrual or habitual hemorhoidal diſcharges, when ſuch ariſe from an undue tention or conſtriction of the parts, or a viſcidity of the juices. Warm bathing ſo ſoftens and relaxes the fibres, as to inlarge the diameters of the veſſels; and while it dilutes and attenuates the juices, by its preſſure upon the external parts, it promotes the propulſion of noxious matters by the proper emunctories. For all theſe like caſes, univerſal bathing is not neceſſary; the half bath, otherwiſe called, Encathiſma, Inſeſſio and Semicupium, is ſufficient; in which the patient ſits up to the navel or region of the ſtomach in warm water, the ſuperior parts being kept dry and covered.

§ 531. There is another kind of partial bathing celebrated for its great efficacy in the relief of heavy and acute pains of the head, inflammations of the eyes, dry and convulſive coughs and aſthmas, hypochondriac and hyſteric melancholy, palpitation of the heart, cholic,

cholic, &c. by the beſt practicioners, antient and modern. I mean the Pediluvium or Lavipedium, the bathing the feet in warm water; by which the pores of theſe extremities are opened, the fibres ſoftened and relaxed, the diameters of the veſſels inlarged, and a flux of humors invited or derived to theſe extremities, to the relief of the more noble parts oppreſſed. Yet, this admirable method of practice, which has its foundation in true phyſical reaſoning, and is confirmed by the experience of ages, is now more frequently abuſed by old women and nurſes, than recommended by regular phyſicians!

§ 532. But, the greateſt efficacy of warm bathing is found in violent conſtriction or coſtipation of the pores of the ſkin or the excretory ducts and paſſages, attended with contractions, diſtentions, ſpaſms and convulſions, with extreme pain.

§ 533. In theſe caſes, warm water brings the ſpeedieſt relief, and that for the following among many obvious reaſons;

§ 534. The ſkin, as has been before obſerved, is the common integument or covering of the whole body. It may be looked upon, as the common emunctory: For, we can conceive no webb, that has more perforations or pores, than the human ſkin. Through theſe, there is a conſtant uninterrupted diſcharge, which ſurpaſſes in quantity all the other diſcharges of the body, and on the regular performance of which the health of men does eſpecially depend. This diſcharge, in the moſt healthful ſtate, is of a greaſy, clammy nature; liable, if not frequently rubbed or waſhed off, to cauſe itchings, eruptions, excoriations, to ſtench and putrefaction, and to clogging and obſtructing the excretory ducts or pores; which are as ſo many common ſewers to a city, to carry off redundant humors, which retained, muſt turn to putrid filth and naſtineſs.

§ 535. The worſt diſorders, incident to man, derive their origine from the later cauſe; to wit, obſtructed perſpiration. Our firſt care then ſhould be

to preſerve this diſcharge in due regularity, or to reſtore it, when by any means ſuppreſſed.

§ 536. This, in many caſes, is moſt effectually done by the rational uſe of warm bathing; by which the diſcharge is kept up, the ſuppreſſion removed or obviated, and thereby the train of evils attending the ſuppreſſion, cured or prevented.

§ 537. The operation of warm water, in this and the like caſes, may be accounted for, from what has been already ſayed, particularly in treating of the nature and properties of water: It muſt diſſolve and waſh away the perſpirable matter, and thereby remove the obſtructions of the pores; it muſt ſoften and relax the fibres, dilute and thin the fluids, promote a free and regular circulation of the blood, increaſe its motion, and promote the ſecretions and excretions, in which the cure of theſe diſorders conſiſts.

§ 538. As there is nothing more conducive to the health of man, than the keeping up this diſcharge, whoſe retention is found ſo noxious; the great and remarkable efficacy of warm bathing in promoting it, and thereby preſerving or bringing about the moſt ſalutary depuration of the juices, will appear from conſidering the effects it produces in ſundry diſtempers ariſing from a morbid ſtate of the juices and the ſuppreſſion of the cutaneous diſcharges.

§ 539. Many chronic and moſt acute diſeaſes are brought on or aggravated by obſtructed perſpiration: Nor can any of them be effectually cured, without reſtoring this moſt neceſſary diſcharge.

§ 540. In moſt Fevers, the antients had recourſe to warm bathing. But moſt eſpecially in the intermittent, in which they preſcribed them, eſpecially in the intervals, and upon the decline of the paroxyſm. The reaſon for this ſalutary practice, which is authoriſed by HIPPOCRATES, GALEN, and CELSUS, may well be collected from what has been before ſayed; as the juices are found viſcid and fizy, the circulation languid, and the perſpiration ſuppreſſed or obſtructed.

§ 541.

§ 541. In burning and continual fevers, warm bathing was recommended, once and in the beginning of the acceſs, by ſome of the beſt practicioners among the ancient Greeks [a].

§ 542. The Egyptians uſed the like practice: For, we are told, that the uſe of warm bathing was common and familiar to that people in all fevers, whether ardent, putrid, continual or intermittent; with exception to the peſtilential onely; but, not ſo much upon the commencement, as towards the decline of the fevers [b].

§ 543. TRALLIAN greatly recommends warm bathing in tertian fevers; eſpecially in hot and dry habits of body, and before the concoction of the morbid humours is performed [c].

§ 544. GALEN recommends it alſo in the like caſes and upon the ſame conditions; and ſays, that it cannot annoy, if it be adminiſtered twice a day.

§ 545. CELSUS is of the ſame opinion; but recommends the bathing, the firſt day, the fever intermits [d].

§ 546. HOFFMAN confirms this method of practice; eſpecially, after clearing the firſt paſſages by aperitive, ſaline medicines; wiſely and juſtly judging, that the morbific, febrile matter can not ſo effectually be diſcharged by any other emunctory as by the pores of the ſkin [e].

§ 547. PLATERUS uſed warm bathing with ſucceſs in quartan fevers, on the days immediately preceding the fit [f].

§ 548. But, the Father of phyſic inculcates this ſage caution, that bathing be not performed in the acceſs, or during the paroxyſm [g].

§ 549. The uſe and reaſon of a practice, thus ſupported by the beſt authorities, muſt be evident to

[a] GALEN, l. viii. cap. 3. Meth. medend. [b] PR. ALPIN. de Medic. Ægypt. [c] Lib. xii. p. 735. [d] Lib. ii. c. 17. [e] Tract laſt cited. [f] Lib. ii. Obſ. p. 281. [g] HIPPOC. de morb. mulier.

every man endued with common ſenſe and a competent judgment in phyſic; yet, we unfortunately find it almoſt quite exploded.

§ 550. But, theſe kinds of acute diſeaſes are not the onely maladies, whoſe malignity is beſt carried off by the pores of the ſkin: For, warm bathing is ſtill found moſt univerſally effectual in the relief of chronic diſtempers.

§ 551. Before we come to give inſtances of theſe, I ſhall mention one kind of acute diſeaſe, for which bathing is found the moſt effectual remedy. I mean that moſt dreadful of all fevers, which attends the bite of mad dogs and other inraged animals, and is attended at the ſame time with an inſatiable thirſt and ſuch a dread of water and other liquors, as occaſions horrors and convulſions at the bare ſight of any of them. This ſtage of this moſt horrible and ſhocking diſorder is called, the Hydrophobia, or dread of water. And for the cure of it, ſudden and unexpected immerſion, and long detenſion, in cold water has been recommended from earlieſt antiquity as the ſole remedy [a]. After which, the patient was to be rubbed with, or immerged in, warm oil, and then diſpoſed to ſweat, by covering up cloſe in warm bed and giving rich wines and other cordials, in which the cure conſiſted.

§ 552. But, though cold water might well produce this effect; yet, it certainly was more likely to be ſpeedily and completely performed by warm water. And accordingly we are informed by CELSUS, that a perſon, bit by a mad dog, was immediately carried to a bath, where he was bathed and ſweated, as long as his ſtrength would admit; leaving the wound open, for the freer diſcharge of the malignant matter. Then, as the moſt ſovereign antidote for all poiſons, they gave him plenty of rich, generous wine. And having continued this courſe for three days, they

[a] CELS. Lib. v. c, xxv. SENNERTUS, HILDANUS, and all the practical writers. Alſo § 460.

judged

judged the patient cured. But, what ſeems to countenance the warm, in preference to the cold, bath, we have from the ſame authority: For, CELSUS in the ſame book and chapter tells us, that if any diſtreſs to a delicate body was apprehended from the cold bath, which ſometimes brought on diſtentions of the nerves or convulſions, and the death of the patient; to prevent this, he was to be immediately after the cold, bathed in warm oil. Which ſhews that warm bathing is more ſafe and effectual than cold.

§ 553. In confirmation of this practice, HOFFMAN [a] cites a caſe, communicated by a certain German phyſician, to this effect: A mad wolfe ran out of a foreſt and bit great numbers of unfortunate men in the neighbourhood. Many of theſe men died before any remedy could be found. At length, an illiterate boor hit upon an effectual cure. He gave each bitten perſon a doſe of Venice treacle and the ſpongy fungus of the dog-roſe, or briar, which is the neſt of a certain inſect, and afterwards put them into a moderately warm bath. He continued them there a conſiderable time, in order to prepare them to ſweat plentifully, and repeted this proceſs for ſeveral days ſucceſſively, which was at length attended with the deſired ſucceſs. By which we ſee, the cure of this virulent fever, as well as that of others, was effected by ſoftening and relaxing the ſolids, cleanſing the pores, diluting and attenuating the juices, inviting them from the center to the circumference, and cauſing the malignity to be thrown off by ſweat.

§ 554. When we conſider the immenſe quantity of ſordid and offenſive matter, that is caſt off by the pores of the ſkin in bathing, we ſhall ceaſe to wonder at the variety of diſtempers, as well chronic as acute, which are remedied by warm bathing.

§ 555. There is hardly any human ſkin ſo clean, as not to foul a large quantity of warm water, upon

[a] Tract laſt cited.

bathing in it. And a bath, once uſed by the cleaneſt perſon, is very apt to corrupt and putrify. In baths, uſed by ſome perſons, a groſs fat ſubſtance has been found afloat, in ſuch quantities, as to be capable of being collected like fat upon broth. Of this kind, ſome remarkable hiſtories are given in the Miſcelanea Naturae curioſa. I ſhall here onely recite two [a]. The one, of a woman, who after having tried all other remedies in vane for a pain in her loins, at length had recourſe to warm bathing, by which ſhe was happily relieved. And a groſs fatty ſubſtance was always found floating on the bath. The other, of an hypochondriac perſon, who upon bathing made the water ſmell moſt offenſively, and left a groſs, thick, black ſcum afloat on it. Theſe daily increaſed with ſuch a degree of acrimony as bliſtered the bather or attendant's hands; till at length, the diſcharge ceaſing, the patient was relieved from his complaints. And the celebrated VOLCKAMERUS tells us of a woman, whom he cured by the ſame means; who diſcharged a conſiderable quantity of this kind of filth every day in the bath [b].

§ 556. It is certain, none other known medicine could ſo effectually bring away this noxious filth, through the pores of the ſkin, as warm water; wherefore, in all caſes, where a diſcharge of that kind is to be promoted, warm bathing muſt prove the moſt ſafe and effectual remedy.

§ 557. Gouty and rheumatick paroxyſms are the moſt painful and diſtreſsful, when the patient or parts affected do not ſenſibly perſpire; and the diſtreſſes are always mitigated by gentle ſweating. Nothing ſooner takes off the tention and criſpature of the fibres and aſſuages the attendant pain; nothing cleanſes and opens the pores and diſpoſes the patient to a mild and gentle ſweat, ſo effectually, as warm bathing. Conſequently,

[a] Decad. II. Ann. vi. Obſ. 239.

[b] HOFFMAN, Tract laſt cited.

it

it well deſerves the attention of phyſicians in theſe intentions.

§ 558. Scorbutic complaints of moſt kinds are aggravated, if not induced, by obſtructed perſpiration. The rational cure of every ſtage of this diſorder, eſpecially that attended with acute pains in the limbs, conſiſts in diſpoſing the humors for diſcharging the morbid matter by the pores of the ſkin. This is done by dilution with ſimple water, warm bathing, and the uſe of acids and other diaphoretics.

§ 559. The laſt ſtage of the venereal evil, that moſt foul, noiſom and excruciating diſtemper, in warm climates, where tranſpiration is moſt free, is much leſs noxious and diſtreſsful, than in theſe northern regions. In Italy and other countries, where they have plenty of natural baths and ſtoves, many men keep this diſtemper moderate during their whole lives, by a courſe of warm bathing and ſweating, performed once or twice a year. And it is certain, that with us, it is never ſo well cured, as by thoſe practicioners, who determine the morbid diſcharges moſt by the pores of the ſkin, by the means of warm baths and ſtoves. Nor, do I believe it can ever be certainly cured, but by theſe means, and upon theſe principles. How many wretches do we daily ſee harraſſed to diſtraction and almoſt to death, often reduced to the worſt hectic ſtate, by long, teadious and violent ſalivations; yet, after a few days reſpite, again tortured with the ſame pains and other direful ſymptoms, for which they were forced to undergo this moſt ſevere and unnatural regimen? Some of theſe unhappy ſufferers, we ſee eſcaping from ſome ſordid cell, contentedly hugging himſelf upon the happineſs of his cure; when, in leſs than a month, all his former complaints rage with more than double fury. If ſuch fall into the hands of the injudicious, they are again put into an other mercurial courſe, in which they rarely meet with better ſucceſs; except, in having an end put to all worldly evils by death. How are they then to be

cured,

cured, before matters are brought to this laſt extremity? By bathing and ſweating onely; without which, the body can never be effectually prepared for a mercurial courſe of any kind; nor can that courſe be duly completed without cloſing it by frequent bathings and ſweatings, which are ſometimes properly and neceſſarily interpoſed during the courſe. Thus, we ſee patients, which after one, two and more ſalivations and divers drenches with mercury in various other ſhapes, in order to vomit, purge or ſweat, to little or no good effect; upon falling into the hands of the judicious, cured by warm bathing, gentle ſweating, and the uſe of a few ſweetning, which are all diaphoretic, medicines. Hence, it appears, that warm bathing and ſweating is in itſelf a palliative, if not a radical cure for the pox; that it is the beſt preparative for a mercurial or other diaphoretic courſe, and that when ſuch a courſe has been puſhed to the utmoſt extremity; ſome of the old leaven of this foul diſeaſe generally remanes in the maſs of humors, which can beſt be expelled, by the pores of the ſkin, duly diſpoſed for ſweating, and cleanſed by a proper warm bath.

§ 560. There are no chronic diſorders more rife among us, and which, after a certain ſtanding, are more rarely relieved by medicine, than Hyſteric, Hypochondriac and Maniac affections. Yet theſe, I apprehend, may be greatly helped, if not often happily cured, by the judicious application of water internally, as well as externally.

§ 561. The ſufferers under theſe melancholy diſeaſes are more or leſs ſubject to indigeſtions, obſtructions of the natural diſcharges; not onely by the pores of the ſkin, but by the other emunctories; as well as to ſuppreſſion of the menſtrual or habitual hemorhoidal fluxes; to an unnatural conſtriction or coſtipation of the bowels, of the inteſtinal channel in particular; with an interruption of their vermicular motion, with ſpaſmodic contractions and convulſions, and in time

time with obſtructions of the liver, ſpleen, pancreas and meſſenteric glands.

§ 562. From the irritation, compreſſion, conſtriction and other diſtreſſes, theſe membranous and nervous parts, of moſt exquiſite ſenſibility, muſt ſuffer in theſe circumſtances, the whole nervous ſyſtem muſt ſooner or later be affected; every juice muſt degenerate, every function be interrupted, if not obſtructed.

§ 563. If theſe diſtempers commence from thoſe diſorders in the firſt paſſages and other lower bowels, our firſt care ſhould be to reſtore matters to rights in theſe parts. And it is clear, that nothing can be thought or found ſo effectual in mollifying and relaxing the indurated and criſped fibres, in reſolving the unnatural conſtriction, coſtipation, obſtruction and compreſſion of the inteſtinal bowels and glands, and in aſſuaging pains, ſpaſms and convulſions in theſe parts, as warm water internally taken and externally applied in baths or ſemicupia. By theſe, a freer and more equal circulation, with all its conſequences, are happily reſtored; and the brain, which was oppreſſed by the influx of the whole crude maſs, is relieved by the invitation or derivation of the humors towards the belly and lower extremities; whoſe veſſels, in the diſordered ſtate, were incapable of receiving a due proportion of the blood, eſpecially thoſe of the limbs, whoſe veſſels are commonly conſtringed, in theſe caſes, by an unnatural coldneſs.

§ 564. In theſe circumſtances, we frequently ſee the moſt violent pains of the head relieved by a pediluvium or bathing of the lower extremities in warm water. And in the fair ſex, when uterine obſtructions bring on, with pains in the part firſt affected and contiguous bowels, convulſions and even epilepſies; they are often cured by the judicious uſe of warm bathing alone, and can ſeldom or never be cured without it: For, if this be not premiſed, moſt hyſteric and deobſtruent medicines may not onely frequently fail in their effects, but often prove dangerous and de-

deſtructive. But, after the fibres of all the ſolids and the juices are, as before explaned, altered by warm bathing; after the lower bowels are relieved from their conſtriction and compreſſion, by this means; not onely in hyſteric, but in hypochondriac affections; then, not onely all the appropriate officinal remedies are given with the utmoſt ſafety and deſired ſucceſs, but the mineral waters, particularly the chalybeate, exert their power and efficacy moſt remarkably, moſt happily.

§ 565. Warm bathing, for the like reaſons, had long been an eſtabliſhed and approved remedy amongſt the antients, in all kinds of Mania or madneſs; though in this, as well as other reſpects, it has become ſo much neglected by the moderns.

§ 566. TRALLIANUS recommends long and frequent warm bathing, eſpecially during the ſummer ſeaſon, in melancholy madneſs [a].

§ 567. ARETAEUS adviſes warm bathing in the ſame complaints, and upon the like principles, with thoſe we have layed down [b].

§ 568. Of the ſame opinions are CAELIUS AURELIANUS [c] and PROSPER ALPINUS [d]. The former of which recommends the natural nitrous baths, thoſe eſpecially, that are inodorous and inoffenſive to the brain; the later recommends univerſal bathing, but particularly, the pumping warm water upon the coronal ſuture; by which, he ſays, many were happily cured; yet, it is a practice, not quite agreeable to

[a] Dulcium balneorum uſus, ſi quid aliud, melancholicis opitulantur: Et paulo poſt———Ægri in balneo morentur diutius, ac in calidum deſcendere cogantur, omnino etiam, ſi aeſtas fuerit, in eo diutius defideant. Lib. i. p. 107.

[b] Melancholicos in aquis ſponte calidis ſaepe commorari, neceſſe eſt; rarae enim & molles ad aegritudinis remiſſionem maxime faciunt, verum ſiccae & tenſae, melancholia laborantibus, carnes ſunt. Lib. vii. m. 134.

[c] Morb. chron. Lib. i. p. 335. [d] De Medic. Ægypt. p. 115.

the

the principles, upon which warm bathing is in general recommended, in diſorders of this claſs.

§ 569. The diſorderly, conſtringed and obſtructed ſtate of the bowels of the lower belly, which cauſe or aggravate hyſteric, hypochondriac or melancholy affections, are not the onely complaints, in theſe parts, for which warm bathing proves a ſovereign remedy: For, it is not leſs effectual in all violent griping pains, convulſive and nephritic cholics, and all ſuch diſorders as ariſe from a dry, tenſe or coſtipated ſtate, where there is no violent inflammation attended with a plethora or fullneſs; in which caſe, veneſection ſhould be premiſed to warm bathing. By this means, the eaſy propulſion not onely of hard or indigeſted matters, of long-retained and indurated excrements in the inteſtinal channel is promoted, but the diſcharge of ſabulous or calculous concretions in the ureters or urethra is happily facilitated, by the ſoftening, relaxing and dilating the paſſages. The operations of the bath in all theſe like caſes are aſſiſted by the internal uſe of warm water in ſoftening apozemes and brothes, or mixed with oils and ſome gentle ſtimulating, neuter ſalts, or ſoap.

§ 570. This method, in this ſort of nephritic diſorders, is not onely countenanced by the beſt writers and practicioners amongſt the moderns, but has been early in uſe among the antients; as TRALLIANUS [a] and ARETAEUS [b] teſtify; particularly the later, who recommends, in ſuch caſes, the ſemicupium, which almoſt inſtantly eaſes the excruciating pains attending the obſtructions of ſtone or gravel in the tender, membranous paſſages; provided the water be not too hot, and the patient too full and ſanguine; in which caſes, it may be hurtful, without due evacuations, and other neceſſary precautions.

§ 571. Thus, we ſee what a vaſt number of diſtempers, external and internal, acute and chronic, may be relieved by the methodical uſe of water in warm, as well as cold baths. To which may be added

[a] P. 543 & ſeq. [b] P. 18.

this

this uſeful remark, that by warm water properly applied, the operations of many of the moſt potent, herculean medicines are at the ſame time mitigated and rendered more efficacious. Thus, for example, all the powerful ſudorifics exert their force with more mildneſs and efficacy, upon having the humors thinned and rarefied, and the ſolids ſoftened and relaxed, than they could otherwiſe do; without this preparation, they may heat and diſtreſs, but may fail of promoting ſweat; whereas, after it, they can neither offend nor fail in the effect.

§ 572. The antients, with great wiſdom and judgment, premiſed warm bathing to the uſe of their hellebores and other draſtic purges and vomits; by which they not onely obviated the pains and ſpaſms, which might otherwiſe attend the uſe of theſe harſh and rough-operating medicines, but more effectually prepared the ſolids and fluids to throw off peccant and morbid matters, with the greateſt eaſe and ſafety. All courſes of mercury, whether for promoting ſweat or ſalivation are rendered much more ſafe and effectual by warm bathing. Nor can ſuch a courſe be with propriety inſtituted or finiſhed, in any caſe, without frequent bathing before and after it: For, by premiſing bathing, the ſolids and fluids are moſt effectually diſpoſed to receive the impulſes of this moſt active, powerful remedy, and to diſcharge the morbific matter, of whatſoever nature it be, by the common emunctory, the ſkin; by which, the violent and often dangerous influx of ſaliva upon the glands of the mouth and throat, is moderated or obviated, at the diſcretion of the judicious preſcriber.

§ 573. The evil effects, that attend chalybeates in female obſtructions and hypochondriac caſes, and thoſe of Peruvian bark, in intermittent diſorders, where they ſometimes cauſe a moſt violent conſtriction or coſtipation of the bowels, with ſuppreſſions of other natural and neceſſary diſcharges, may be prevented

vented or relieved by the prudent adminiſtration of warm bathing.

§ 574. It is now fit we ſhould cloſe this head with ſome neceſſary directions and cautions concerning the uſe of baths.

§ 575. 1. The proper ſeaſons for courſes of bathing are the warm months of the year, thoſe very months, when the modern practicioners ſend away their opulent, as well as other, patients from the baths, and make room for the neglected beggars to meet with cures, which this ill-judged practice denies to the rich. But, of this, more in its proper place. Here let it ſuffice to ſay, that as cold weather is the beſt ſeaſon for cold bathing; ſo is warm weather the beſt ſeaſon for warm bathing. For, ſimple warm baths, ſince the time of GALEN [a], were looked upon as humecting and cooling. Though, notwithſtanding, either may with due care and caution be applied in any ſeaſon, known in our temperate climate. It is certain, that cold bathing does moſt ſervice to thoſe whom it warms, and warm bathing is moſt effectual, where it cools, rather than heats. Both are deſireable then, at different ſeaſons of the year. And, as the patient, who uſes the cold bath in winter, is thereby defended from the inclemency of the weather and prevented catching cold; and he, who uſes the warm bath in the ſummer, is apt to find the warm air, which he, before bathing, judged ſultry and intolerable, temperate and grateful, if not cool after it, and is however leſs liable to catching cold in that temperature of the air, than in any other; it is evident, the ſeaſons for cold and warm bathing are quite miſtaken among us, and that we ſhould have recourſe to our cold baths in winter, and to our warm baths in ſummer [b].

§ 576.

[a] Lib. i. Artis curativae ad Glauconem; p. 457.

[b] This is further countenanced, againſt the modern practice, by the great SANCTORIUS; in his invaluable tract, Medicina Statica, § II. Aphoriſm. I. before cited, § 483. 4. as well as in Aph. II. which

§ 576. 2. The time of the day generally recommended for warm, as well as cold bathing, is in the morning early, ſleep and digeſtion being well performed, and the urinary and alvine excrements diſcharged. This may be a proper time in the former, for ſuch patients, as are able and fit to go into the cold bath, and thence into the open air, after warm bathing. But, as the generality juſtly adviſe the patients, after warm bathing, to go into a warm bed, either to ſweat or cool gradually or both; I ſee none objection to the bathing at night, upon an empty ſtomach and bowels, when one may go into bed for the whole night, and ſweat, ſleep and cool at leiſure, ſo as to be in no danger from going, with due caution, into the open air the next day; which can not commonly be done with ſafety on the days, upon which one bathes in the morning. Beſides, wearied travellers can not be denied the comfortable refreſhment of warm bathing; which moſt effectually procures them reſt and reſtores their ſpirits after extreme fatigue.

§ 577. 3. No perſon ſhould ſtay longer in the bath, than he finds it refreſhing and invigorating. Except ſuch as are bitten by mad dogs or other inraged animals, or maniacs, whom it may be found neceſſary ſometimes to continue in the bath, until they grow faint.

§ 578. 4. All perſons ſhould be forbidden much active motion or ſpeaking in a warm bath; as it greatly exhauſts the ſtrength and diſtreſſes the organs of breathing, then under a conſiderable additional preſſure to that of the atmoſphere, and repleniſhed with the rarefied juices.

§ 579. 5. No perſon, except maniacs and thoſe bitten by inraged animals, ſhould be forced to bathe,

which I here tranſcribe,—Aer calidus et lavacra actu calida, niſi obſtent cruda, juvant quoque perſpirationem, refrigerant interna viſcera, et corpora efficiunt leviora.

when

when it raiſes any degree of Terror or Horror [a], nor at the approach of any epileptic or other convulſive fit; becauſe thoſe inordinate orgaſms of the ſpirits may be greatly increaſed by the dread of the bath.

§ 580. 6. No perſon with full bowels or blood veſſels, or with any inflamed, obſtructed or much weakened bowel, ſhould be admitted into a cold or warm bath; leaſt crudities, in the firſt and ſecond paſſages, ruptures, hemorhages, or an increaſe of thoſe diſorders, may be the conſequences [b].

§ 581. 7. The head in general is to be kept out of the warm bath, dry and ſlightly covered; and in ſome caſes, it is to be left bare, or covered with a napkin wet with cold water; as where the patient is ſubject to influxes of blood on the brain, or eyes, to pains in the head, drowſineſs, &c.

§ 582. 8. The reſt of the body ſhould be quite naked; except a convenient little garment, which may be carried betwixt the thighs, and ſupported by a piece of tape about the waſte, before and behind, to hide thoſe parts, which modeſty bids us conceal from each other's ſight. Whoever goes into a bath, hot or cold, particularly the former, in any, eſpecially a tight or cloſe, garment, does not receive half the benefit, he might expect. The efficacy of warm bathing, in a great meaſure, depends upon having a conſtant ſucceſſion of new water coming into contact with the ſkin, while a perſon remanes in the bath. But, when one goes into a bath in a cloſe veſtment, he is to expect little or no more water to come into contact with, and to diſſolve and waſh away the foulneſs of, his body, than what his garment, at firſt immerſion, receives, which it holds, until he makes his exit. This conſidered, I ſhould be glad to hear how the modeled practicioners, who countenance or connive at the ſexes bathing promiſcuouſly and in ſtiff, cloſe, canvas habits, can reconcile this cuſtom to decency and common ſenſe: I ſhall not require their reconciling

[a] GALEN. de morb. cur. lib. xi. [b] GALEN, part laſt cited.

it to the rules of phyſic; it would be moſt unreaſonable to demand an impoſſibility.

§ 583. 9. The next thing to be conſidered is the regulation of the temperature of the Bath. On this greatly depends the recovery and ſafety of the patient: And it is not difficult to be done; ſince, by the uſe of the Thermometer, every degree of heat and cold can be ſo eaſily and effectually aſcertained, that where baths are regularly conſtructed and rationally conducted, the phyſician can direct the degree of heat of the bath for his patient, with as much certainty, as the number of minutes, he would have him remane in it. How this is to be done, where the baths have none other covering, than the extended canopy of heaven, let any thinking man conſider. What phyſician or patient can be ſecure of the neceſſary degree of heat in the water, two days ſucceſſively, or any two hours in any one day, in the naked baths of our Bath? What chance of performing cures there, in the cold ſeaſons eſpecially, which are the chief times deſtined for bathing in thoſe open ponds of uncertainly heated waters; ſo little, if at all, improved ſince the times of our hardy, barbarous anceſtors the Britons? But, no more of this, until we come to treat expreſly on theſe powerful, unknown, though much frequented and abuſed, waters. Let me here onely give this general caution in the uſe of baths, that no perſon goes into any bath, heated above ninety-four degrees, which is found to be the heat of the blood in the natural healthful ſtate, taken by Fahrenheit's thermometer; unleſs it be expreſsly directed by a phyſician upon ſome extraordinary emergency, to increaſe the degree of heat.

§ 584. Under this head, two other kinds of warm bathing; to wit, 1. the pump, and 2. the vapor bath may not improperly be conſidered.

§ 585. 1. The firſt form of bathing was known to the greeks by the name of ἔμβρεγμα and ἐμβροχή, Embregma and Embroche; to the romans, by thoſe of Stillicidium, Inſtillatio and Irrigatio; and is now called,

called, by the Italians, Doccia, by the French, la Douche, and by the Germans and us, from the ordinary manner of applying it among us, die Pompe, the Pump.

§ 586. By this, is meaned a contrivance, by which any convenient liquor, but chiefly water, cold or hot, may be cauſed to deſtil, run or fall, from ſome diſtance, upon the whole, or any part of, the body.

§ 587. The beſt method of making this kind of bath is by raiſing the water of any natural or artificial bath into a receptacle of a convenient ſize and heighth, by means of a pump or other proper machine. This receptacle is to be furniſhed with one or more flexible tubes, to which may be occaſionally adapted, cocks with one, or many orifices of different dimenſions and forms, to apply the ſtream of warm water in any proportion, direction, or force required, to any part affected.

§ 588. Here then, is added to the ſoftening, reſolving and penetrating power of water, that of friction; by which it is capable of doing inexpreſſible ſervice in old hard and cold tumors, ſtiffneſs and contraction of the joints, gout and rheumatiſm.

§ 589. The patient may either ſit or lye in the bath, or out of it, as is found moſt convenient, to have the ſtillicidium applied to the particular part affected. And the ſame cautions are to be uſed to avoid cold after this application, as after general bathing.

§ 590. The power of the friction of the water may be greatly increaſed, by forcing it by any proper pump into a braſs or copper ſphere, to which a cock with a flexible leathern tube is fixed; by which the water may be driven by the ſpring of the incloſed air in the ſphere, added to the gravity of the water. By this means, this method of applying water muſt be rendered moſt effectual in old, hard, indolent tumors, contractions, &c.

§ 591. 2. The ſecond is a form of bathing not known or uſed among us; though the moſt powerful, the moſt effectual of any.

§ 592. This ſeems to have taken riſe among the Romans, in whoſe immediate territories, nature furniſhed many vapor baths; as in ſeveral places about Naples, Puteoli, the Bajae, celebrated by HORACE and CELSUS, with many others of inferior note. Theſe were called by the names of Vaporarium, Laconicum, and Sudatorium; in faint imitation of which, were contrived the ſtoves, afterwards called by the ſame names, as well as by thoſe of Stupha, or Stuffa, the later by the Germans, who invented them in imitation of the natural, and called them Badtſtuff, in their language, and in a ſort of fictitious latin, Stuffa.

§ 593. This is certainly the moſt ſafe and effectual ſudatory known: Nor can there be an inſtance given of its failing, in fit ſubjects, under due regulation. We have already had occaſion to explane the operation of warm baths; whatever holds true of them, holds alſo good in the vapor bath. This may eaſily be conceived, upon recollecting what has been ſayed of the power of water converted into ſteam, in Papin's digeſter and other more common machines. By this means, the hardeſt part of animals, may, in a ſhort time, be reſolved into a gelly. Hence, the reſolving power of the vapor of warm water upon an animal body may be judged. This vapor ſtriking againſt the body is partly condenſed into water, whileſt a part enters the pores. When the vapor is confined about the whole body or any part thereof, it muſt act more powerfully. It then warms, ſoftens, relaxes, opens the pores, penetrates the remoteſt receſſes, reſolves and attenuates viſcid and cold humors univerſally, and fits them for a diſcharge by the ſkin, in a bland and copious ſweat, partly in the bath and partly in bed after it. By this means, paralytic diſorders ariſing from any viſcidity of the juices, anaſarcous and oedematous tumors, whether partial or univerſal, pains and contractions of the limbs or joints, and numberleſs other evils of this claſs are moſt happily and effectually relieved.

§ 594. From the many inſtances of the ſalutary effects of warm vapor bathing, which I had obſerved

at Aken, I was induced to contrive a ſudatory upon the ſame principles with theirs; judging, that the efficacy of their vapor baths was not ſolely owing to the ſubtil, mineral effluvia, with which they are charged, but chiefly to the particles of water moſt ſubtilly attenuated and ſet in motion by heat; or at leſt, that a ſimple vapor bath might probably produce very deſirable effects.

§ 595. This ſudatory conſiſts of a kind of chair made of four planks or pannels, of about two feet four inches broad, and about five feet in length or height. Theſe are cloſely joined together by hinges; ſo that they may be folded up for the conveniency of carriage, or placed upright and by hooks faſtened to a ſquare Plank, that ſerves for a bottom or foot-board; and then, one pannel makes a back, two others conſtitute the ſides of the chair, and the fourth ſerves for a door. To this chair there is a ſliding ſeat, with a thin ticking ing bottom, that, like the moveable ſhelf of a library or book-caſe, may be raiſed higher or placed lower, according to the ſize of the patient. At the top, there is ſuch another contrivance; but the board, which fills the whole ſpace, is placed ſhelving, from the back forward, for the greater freedom in breathing; and is divided into two, each part of which is hollowed to the ordinary ſize of an human neck. This is adapted to the ſize of the patient; the back-piece is put in firſt, the patient is then ſeated, naked on the ſeat, and the fore part is added. Then the door is cloſed and the vapor admitted by the means of the following aparatus, which conſiſts of,

§ 596. 1. A flat copper kettle to hold about ſix quarts, to which an head is adapted ſomewhat like that of a common alembic; but with a ſmaller head in proportion; as it is not deſigned for condenſing, but conveying the vapor by a tube, of about three inches in diameter, continued from the head into the lower part of the back of the ſweating chair, and by moveable pieces turned in any direction deſired. About the neck of this kettle, there is an opening, by a ſhort pipe

pipe of about an inch and half in diameter; by which a ſupply of new hot water may be given without interruption; or the vapor medicated by the addition of any ſpirit or other volatile, aromatic medicine; or the heat moderated or ſtopped, by the addition of cold water, at diſcretion.

§ 597. 2. A low copper ſtove or little furnace with its fire place, aſh hole and regiſters, made to receive the bottom of the above kettle, and to hold fire enough to keep the contents boiling; yet, ſo as, by ſhutting its doors and regiſters, the fire may be in an inſtant ſuppreſſed and the boiling and vapor made to ceaſe.

§ 598. The patient ſits naked in this chair, with a napkin about his neck to keep the vapors from coming out and anoying his head or lungs; and may be continued in it, and ſupplied with drink or cordials, according to the preſcriber's intentions.

§ 699. It is eaſy to ſee the different advantages this holds from the common ſtoves or hot-houſes in Bagnios; where the head and lungs of the patient muſt be injured by the heat and by breathing ſuch an highly rarefied and offenſive air, as muſt be in ſuch hot and confined places. Beſides, in this, you may have the moſt abſolute power over the ſudatory, by admitting more or leſs vapor, ſimple or medicated, at diſcretion, or by totally ſtopping its courſe: Which can not be done in the common ſuffocating ſtoves at the Hummums.

§ 600. By contriving boxes to contain particular affected limbs, a partial vapor bath, ſimple or medicated according to the preſcriber's intentions, may be readily adminiſtered; than which, there can not be a better, nor, in many caſes, ſo good a Fomentation.

§ 601. By different pieces of tubes, ſome ſtraight, others angular, with a roſe, like that of a gardener's watering pot, ſuch a vapor may be conveyed to any part of the body. And I am perſuaded, that by ſuch a vapor properly conveyed to the ears, many pains of theſe parts and deafneſſes may be cured, that do not give way to any other known form of medicine.

§ 602.

§ 602. This ſmall machine, I have contrived to make it portable. But, it is not difficult to make it more effectual by inlarging upon this plan. And, if what I have here offered upon the uſe and efficacy of water variouſly applied in the relief or prevention of the almoſt numberleſs diſorders incident to the frailty of human nature, may be hoped to have any weight, we may expect to ſee all the neceſſary conveniencies for the ſeveral kinds of baths eſtabliſhed in every conſiderable houſe in the country, and regular and well-furniſhed Bagnios encouraged and ſet up in every town. And, that the poor may not be excluded the benefit of the helps, which are to be drawn from this quarter, at a moderate expence; I beg leave to recommend it to the public to extend their benevolence to their ſuffering fellow creatures; and, by a charitable contribution, eſtabliſh public baths, both cold and hot, to which the poor may have eaſy acceſs. It would likewiſe be not onely an act of great and true charity, but the beſt policy, to eſtabliſh proper baths in all bridewels, goals, and other places of confinement; where, by obliging the wretched, who from filth and naſtineſs, contract the moſt malignant and peſtilential diſeaſes, frequently to waſh and cleanſe themſelves, much of the calamity, and the dreadful infection may be obviated, which they ſo commonly ſuffer and ſo often impart to the reſt of the ſociety, in general goal deliveries. It is alſo, in mine apprehenſion, to be wiſhed, that many of thoſe, who are confined in various diſeaſes in hoſpitals, were put upon the ſame cleanſing, wholeſom regimen; and that our ſailors, in long voyages, were obliged to make frequent bathing a part of their ſalutary diſcipline; which would certainly help to keep them free from ſcurvies and other diſorders, to which they are found too ſubject.

§ 603. I ſhall cloſe this part of my diſſertation with an obſervation and propoſal, which I think extremely conducive to the end propoſed by this and all my poor labours, the common good of the Republic.

§ 604.

§ 604. I presume, it must be obvious to every reader, who has attentively read this tract, thus far, that there is nothing known, that bids so fair for the character of the much, but vanely, sought universal remedy, as common water; since nothing is found so necessary to life, so effectual in preserving present, or restoring lossed health, as water.

§ 605. I therefore venture to recommend its more frequent use to the public in general, and that it may be further introduced into practice in our hospitals in particular, than it is at present found. But, if from the constitution of particular foundations, which I look upon to be so sacred, as to be, for the most part, unalterable; this may be found in most impracticable, I humbly propose it to the consideration of BRITONS, more remarkable, more justly famed for public benevolence, for making provisions for the health of the bodies and minds of the indigent, in the erecting alms-houses and hospitals, scholes, colleges and other seminaries of literature and arts, than any other people, or perhaps, than all the other nations on the globe united can boast; to erect and establish, in the capital and other great cities, one or more Bath or Water-hospitals; where physicians, with proper attendants, may be appointed, and poor in all fit cases, at all times readily received and supplied with light, simple diet, clean beds, baths of all kinds, and water simple and variously medicated of different degrees of heat and cold adapted to the generality of cases, that may offer.

§ 607. Such an hospital may be built, planely and elegantly, contiguous to a navigable river for the sake of fewel, and may be supported at a much less expence, than any of the present foundations, and may vie with any of them, if not outdo most, in utility and benefit to the public.

The End of Part I.